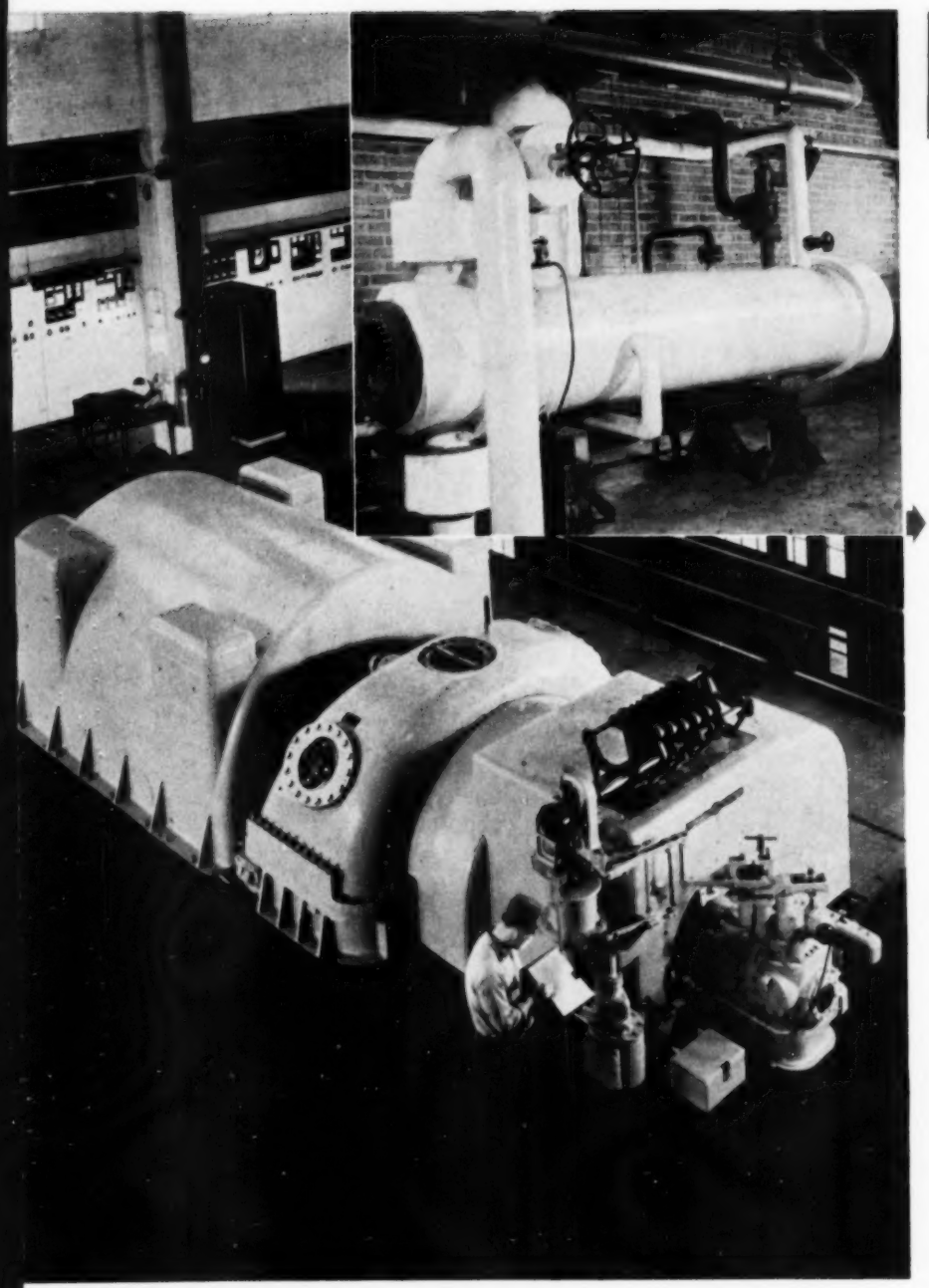
Industry and Power

May 1953



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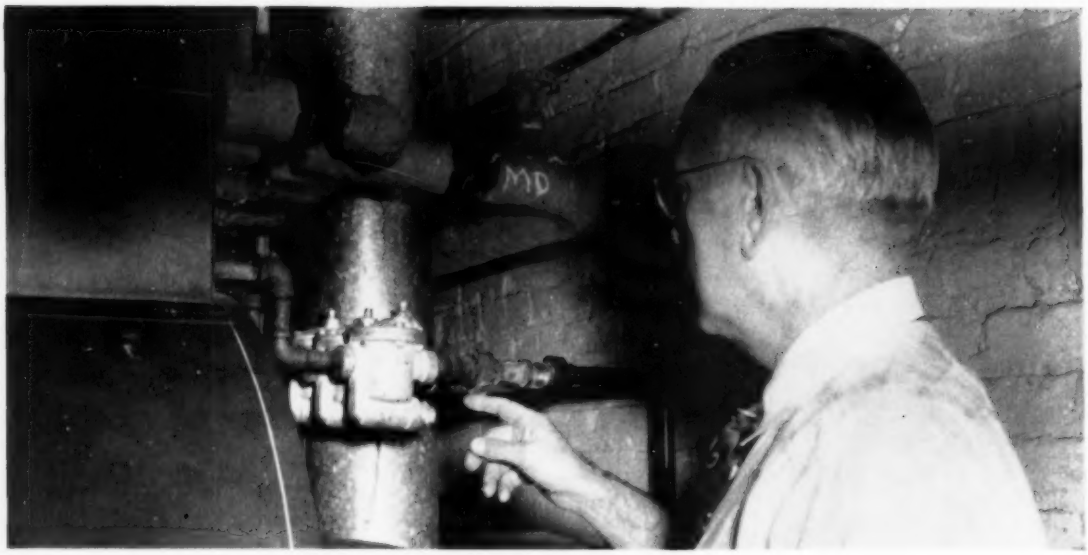
— for engineered plant services

User Explains How Armstrong Unit Trapping Boosted Output:

Need for Investment in New Steam Equipment Eliminated by Only $550.00 in Steam Traps



THIS is a story about greatly increased efficiency in a laundry, but the principles involved apply to any plant using steam heated equipment.

In speaking of the benefits derived from Armstrong Unit Trapping, Earl Fast of Soft Water Laundry and Cleaners, Long Beach, California, said, *"It's like a man with dirty eyeglasses—he thinks he's seeing perfectly until he cleans the glasses and finds out what he has missed."*

Mr. Fast's plant modernized its entire return system in 24 hours, installing 71 Armstrong traps costing about $550, with these results:

1. Capacity of machines costing as much as $15,000 per unit increased to the extent that new machines are not now required.
2. Higher quality of ironing and finishing, with touch-up on shirts eliminated.
3. Worthwhile fuel savings.

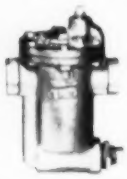
"Our boiler was turning out plenty of steam," continued Mr. Fast, "but we weren't getting the benefit of it. The best power plant in the world is of no value if you don't use its produced steam to maximum efficiency."

And there lies the case for Armstrong Unit Trapping, which discharges air and condensate as fast as it accumulates to keep steam heated equipment hot and producing at a peak rate. Your local Armstrong Representative will be glad to survey your condensate drainage system without obligation. Call him or write:

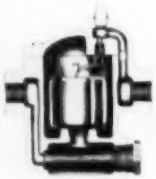
ARMSTRONG MACHINE WORKS
820 Maple Street • Three Rivers, Michigan

Traps with Built-in Strainers Cut Costs

Because the piping at Soft Water Laundry was old, the smallest-sized traps needed protection against dirt and scale. Armstrong No. 880 and 881 traps with built-in strainers were the logical answer because:



1. They cost less than a separate trap plus a strainer.
2. They eliminate external fittings and considerable installation labor.



Left—Cut-away view showing strainer screen at trap inlet. Strainer can be cleaned without removing or shutting off steam.

You always get more out of equipment when you use Armstrong "Unit Trapping"

FREE
44-PAGE STEAM TRAP BOOK
Gives Complete Information
MAIL TODAY!

FILL IN AND CLIP TO YOUR COMPANY LETTERHEAD

ARMSTRONG MACHINE WORKS
820 Maple Street, Three Rivers, Michigan

Please send me a Steam Trap Book.

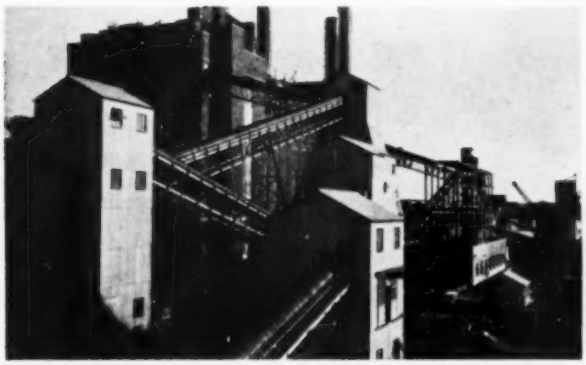
Name .....

Title .....

From barge to bunker...

One of two Link-Belt Speeder Cranes unloads barges. The Link-Belt system then transfers coal to storage bunkers or to ground storage.

LINK-BELT cuts coal handling costs



Recent addition at this station included twelve 24-in. Link-Belt belt conveyors. En route to bunkers coal is crushed and weighed.

Two of six Link-Belt belt-propelled trippers empty coal into storage bunkers. Link-Belt Series 100 Idlers are used throughout.

Eastern power plant utilizes LINK-BELT's proved engineering and equipment for top efficiency

WHEN this power plant wanted to increase its coal handling capacity to 325 tph, they chose Link-Belt. With eight years' successful operation of an earlier Link-Belt system, they knew they could expect top efficiency.

Now, from the time two Link-Belt Speeder pedestal-mounted cranes unload river barges . . . until six belt-propelled trippers discharge into storage bunkers—handling is completely mechanical. By integrating the old and new systems, complete flexibility is achieved.

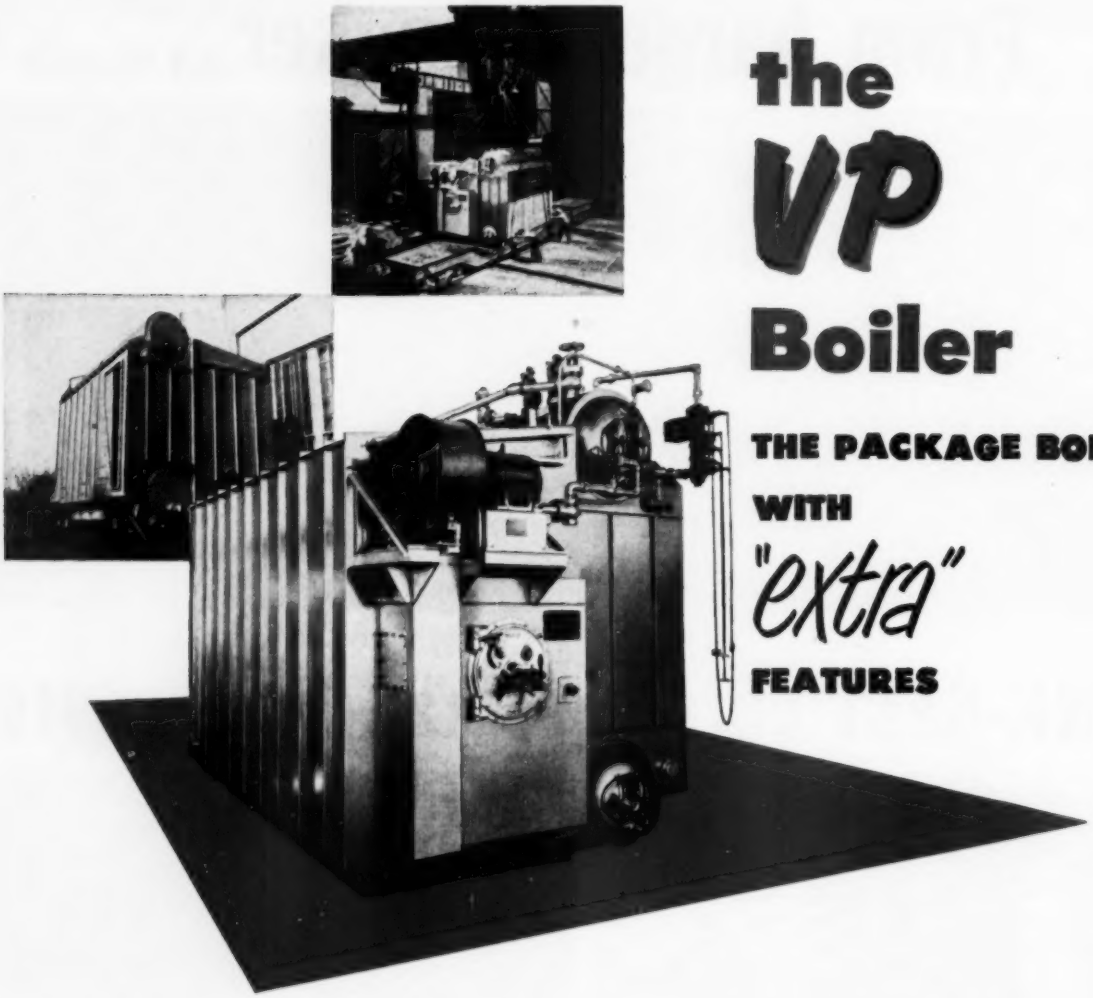
Whether your coal requirements are large or small, you, too, will find it pays to rely on Link-Belt. There's a 44-page book—No. 2410—that shows scores of typical modern power plant layouts. Ask the Link-Belt office near you for a copy.

LINK-BELT

COAL HANDLING EQUIPMENT

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices in Principal Cities.

19.211



the VP Boiler

THE PACKAGE BOILER WITH "extra" FEATURES

Most of the water-tube "package" boilers available today look very much alike. As a matter of fact, in some respects they are alike.

The prospective purchaser's job is to discover which of the several package boilers now available offers a combination of features and advantages that adds up to the "best buy".

Consider, then, the fact that the C-E Package Boiler, Type VP, has *all* the design features offered by any of its contemporaries *plus* the important extra features described at the right.

VP Boilers are available in capacities from 4,000 to 30,000 lb of steam per hr; pressures to 250 psi. Send for Bulletin VP-13.

FULLY WATER-COOLED FURNACE — Even the front or "burner" wall is protected, except in three smallest sizes. Has higher ratio of furnace-wall cooling to furnace volume than any boiler of its size and type. Assures rapid and efficient heat absorption, lower gas temperatures entering convection bank, reduced tendency to slag formation. Minimizes furnace maintenance.

LARGER LOWER DRUM — The large lower drum, 30″ in diameter, permits simple, symmetrical tube arrangement; provides easy access when necessary for washing down or for inspection; greater water storage capacity facilitates handling fluctuating loads.

CENTRIFUGAL FAN — This type of fan is more efficient, operates at lower speed and is quiet in operation. The average noise level is less than half that of typical high-speed blowers used on most boilers of this type. Low noise level is particularly advantageous in confined space and in such installations as hospitals.

SIMPLE BAFFLE ARRANGEMENT — Minimum changes in direction (no baffle at all in convection bank in larger size units). Gives lower draft loss. Simplifies soot blowing. Cross-flow of gas with elimination of dead pockets gives maximum heat pick-up. Water-cooled baffle in intermediate sizes insures minimum maintenance.

B-652A

COMBUSTION ENGINEERING, INC.

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

Industry and Power

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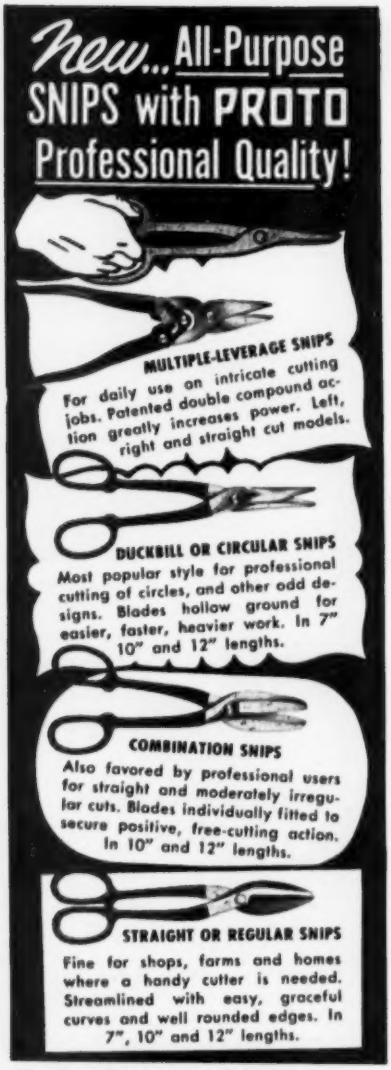
INDUSTRY AND POWER including INDUSTRIAL POWER, is published monthly by Maujer Publishing Company, 420 Main Street, St. Joseph, Michigan. Member of Controlled Circulation Audit and National Business Publications, Inc. Acceptance under Section 34.64 P.L.&R. authorized by U. S. Post Office. Form 3547 requested. Copyright 1953, Maujer Publishing Company.

Subscription information: Mailed without charge to executives and engineers, in selected plants and organizations, who are responsible for the selection, installation, operation and maintenance of equipment required for Engineered Plant Services. To all others there is a subscription price of $10.00 per year in the U.S. Outside U.S. subscription price is $15.00. Single copy $1.00. Address subscriptions to John B. Klein, Circulation Manager.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Los Angeles 54, Cal.

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PROTO TOOLS

Eastern Factory—Jamestown, N.Y.

acorns

. . . recently announced . . . worth watching

Aluminum Windings

● Distribution transformers in a number of ratings have been developed for voltage ratings below 15 kv using aluminum windings. Any future shortages of copper or marked increases in copper prices will undoubtedly inspire wider use of aluminum-wound transformers. Present data indicate over-all weight, dimensions, and electrical characteristics practically identical to copper can be obtained in transformers rated from 5 to 333 kva.

Atomic Power Reactors

● Central station atomic power reactors with generating capacities over 100 megawatts are forecast within the next five years. The first power reactors will probably be used where fuel storage capacities are limited and where mobility is of prime importance—the military seems likely to use such stations. As reactor technology becomes more fully known, it is predicted that atomic reactors will bridge the gap between exhaustion of fossil fuels and successful utilization of solar energy. This transition period is thought to be of many hundred years' duration.

High-Temperature Transistors

● Electronic equipment for industrial applications can now apply the wonder-component of electronics — the transistor. A new type of transistor has been announced which will perform satisfactorily at high temperatures which usually characterize industrial environments. Temperatures as high as 212 F and high humidities do not impair the operating characteristics of the new transistor.

Chemical Nickel Plating

● Nickel plating by chemical means has been announced; no electrical devices are used. The plating thickness can be controlled to within 10 per cent of the nominal thickness regardless of the shape of the part being plated. Zero porosity is reported on practically all surfaces—severely pitted or defective base metal gives rise to negligible porosity. Pickling, cleaning, and rinsing techniques for the new process are about the same as those used presently in electrolytic plating.

Zirconium Fabrication

● Fabrication of zirconium on a full commercial scale will be achieved this year. Forming, rolling, and machining operations on this metal have been developed as an adjunct to the development of atomic power reactors. As atomic power comes nearer to commercial application, the use of zirconium techniques now being formulated will become more important to industry.

Radioisotopes Forge Ahead

● Some 12,800 shipments of radioisotopes have been made to industrial firms by the Atomic Energy Commission. Pioneering companies have applied them to thickness gaging, tracing and identification, and wear studies.

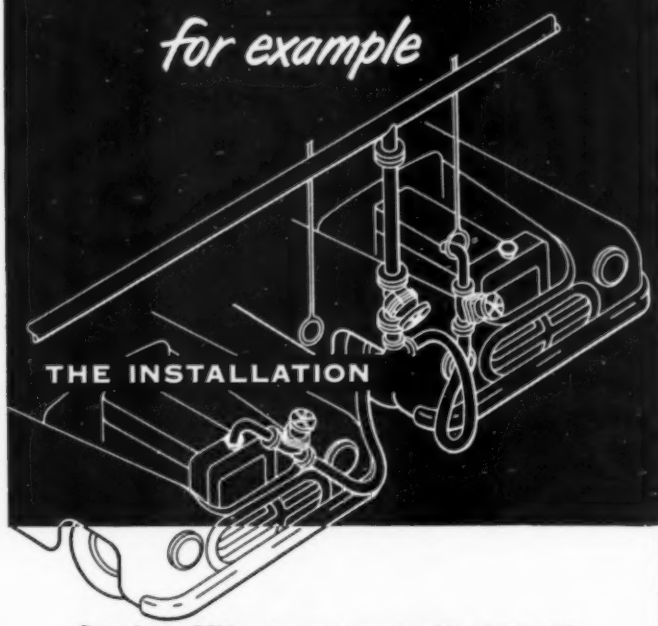
Automatic Factories

● Techniques have been announced whereby machine tools can be operated from punched tapes and similar memory devices. To change the product of the machine, a new punched tape replaces the original tape. Such flexibility minimizes down time for setups. Fewer parts need be stockpiled since additional parts can be put into production by merely threading a tape through the machine. There are none of the human frailties to introduce deviations on account of fatigue and no limits such as humans experience in tiring repeat performances. The instrument brains which can accomplish these feats have been long used by the military in fire-control and similar applications. Their conversion to industrial use should therefore involve few "bugs" since most have been met and conquered.

Moving Sidewalks

● People will be placed on conveyor belts when the moving sidewalks now on drafting boards become realities. Large cities will also relieve traffic congestion by using underground and overhead conveyor systems.

How Valve Life Changed from Days to Months ...on Crystalline Liquids, for example



In a large Midwestern auto assembly plant, with Crane Diaphragm valves in alcohol solution anti-freeze fill lines to automobile radiators.

VALVE SERVICE RATINGS

SUITABILITY:	Doing the job O.K.
FEATURES:	Packless; no leakage around stem
MAINTENANCE COST:	None
SERVICE LIFE:	Now 25 times longer than any valve used
OPERATING RESULTS:	Damage to production stopped
PRICE:	O.K. No premium
AVAILABILITY:	Regular Crane Catalog item. No. 1610

THE CASE HISTORY

None of the many conventional valves nor the plug cocks tried in this service lasted more than a week—about 2,000 operations.

The crystals present in anti-freeze would build up on seating surfaces and in the exposed valve stem threads. The valves leaked and were hard to operate. To the excessive maintenance needed was added the high cost of frequent damage to automobile finish by anti-freeze leakage.

Now Crane Packless Diaphragm valves control the trouble. Their sealed bonnet prevents contact of fluid and working parts; their seating design isn't hindered by crystal deposits. At last report, Crane valves have given over 50,000 trouble-free operations with no maintenance, and with indefinitely longer life assured.

THE VALVE

In Crane Diaphragm valves, the diaphragm serves only to seal the bonnet, not for seating. It isn't pinched or stressed when valve is closed. Independent disc gives control of fluid even should diaphragm fail. These valves are made in a wide variety of body, diaphragm, disc-insert, and body-lining materials to handle countless corrosive, abrasive, or ordinary services. See your Crane Catalog or local Crane Representative.

THE BETTER QUALITY...BIGGER VALUE LINE...IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
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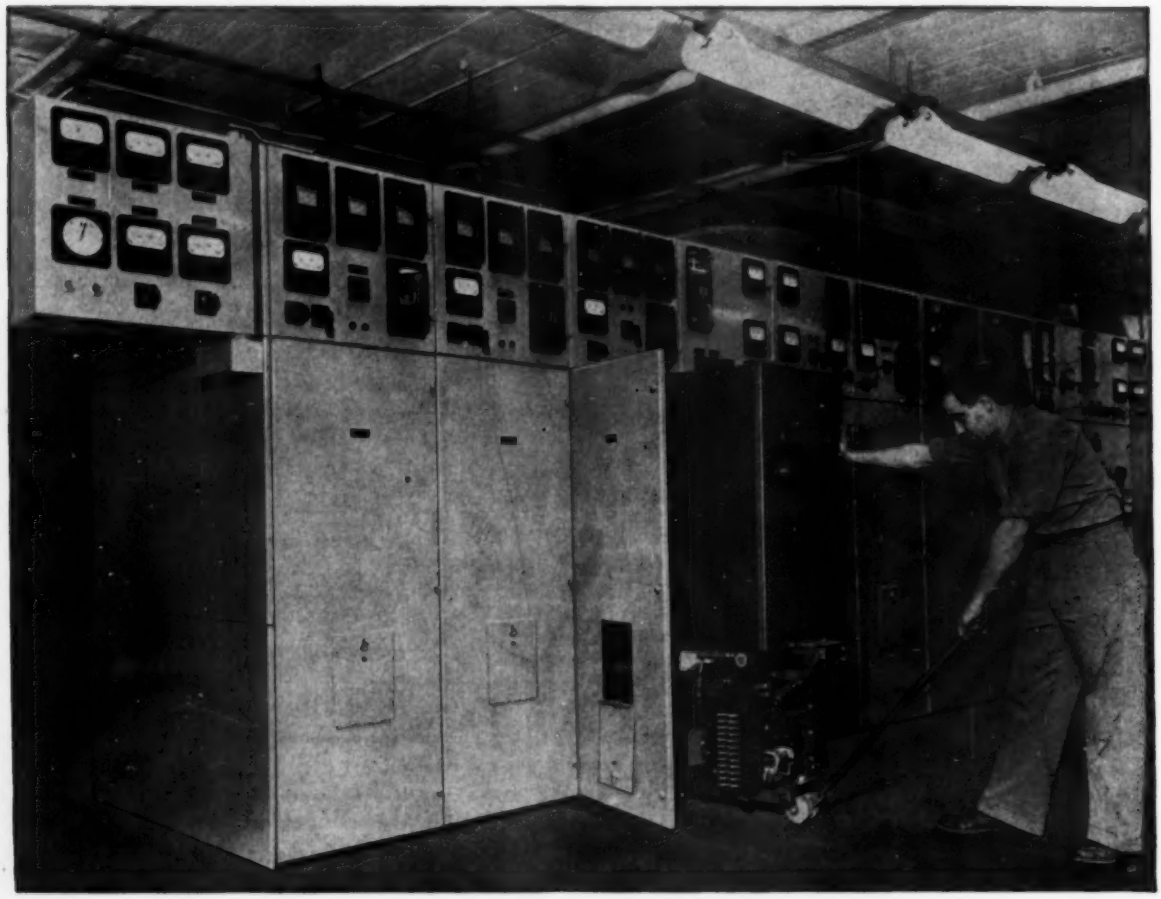
I-T-E Horizontal Drawout Switchgear



I-T-E Metal-Clad Switchboards complement latest engineering advances with neat, modern design. HV circuit breakers are easily withdrawn from compartments. Safety is the keynote.

Indoor and outdoor equipment in ratings: 4160 volts—50,000, 150,000, and 250,000 KVA interrupting 600, 1200, and 2000 amperes continuous

20 years and more of easier handling

Modern switchboards last 20 years or longer. During this period, you can expect periodic inspections, load changes, certain maintenance, and, of course, short circuits and overloads.

Consider the outstanding advantages to yourself of I-T-E *horizontal drawout* switchgear over the life of the equipment in each of the following instances:

When inspections are made

Truck-mounted circuit breakers can be wheeled out of compartments quickly and easily. Safety shutters isolate "live" contacts in the compartment. Connected equipment can then be examined carefully without danger to personnel.

When loads change

Relay settings are quickly adjusted to compensate for load changes. On wider load variations, current transformers may be changed. Isolation of compartments in Metal-Clad construction permits these changes without interference with the main bus. Circuit breakers may be removed from their compartments to assure complete safety. Horizontal drawout circuit breakers in drawout switchboards make this possible and *convenient*.

When maintenance is performed

Each circuit breaker is withdrawn from switchboard, checked, and adjusted if necessary. Service continuity is assured. While the circuit breaker is out of service, a spare can be used to replace it. One spare circuit breaker provides adequate insurance for many feeder circuits.

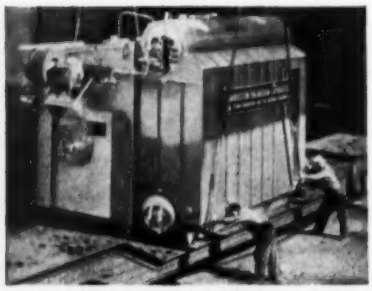
Your local I-T-E sales engineer will be glad to show you the specific advantages of Horizontal Drawout Switchgear in your own application. Or for complete details on I-T-E Metal-Clad Switchgear, send for Bulletin 7004-B, Dept. —, I-T-E Circuit Breaker Co., 19th & Hamilton Sts., Philadelphia 30, Pa.

METAL-CLAD SWITCHGEAR

I-T-E CIRCUIT BREAKER COMPANY
19TH AND HAMILTON STREETS • PHILADELPHIA 30, PA.
I-T-E Equipment Division • Greensburg, Pa.

new equipment

and new developments

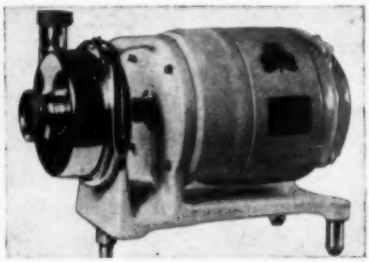


Package boiler features large waterwall area

E10 Combustion Engineering, Inc. has developed a compact, package steam generating unit for operation up to 250 psi, with steam capacities ranging from 4000 to 30,000 lb per hr. Known as type VP, it is a two-drum, vertical bent-tube design with a water-cooled furnace in front of the convection surface. A high ratio of furnace-wall cooling to furnace volume is said to provide rapid and efficient heat absorption and lower gas temperatures entering the convection bank. It is completely shop-assembled, and is designed for pressure firing of oil or gas, either alone or in combination. A centrifugal type forced-draft fan is used to provide quiet operation.

Space heater design permits easy maintenance

E11 Incorporated in suspended space heaters developed by the Heating Dept. of the Machinery Div., Dravo Corp., is a cast iron bunsen type burner assembly which can be removed quickly for servicing and cleaning. The drawer frame slides out with the mounted burners and all controls, making them easily accessible. Units are suitable for natural, manufactured, mixed, liquid petroleum, sewage, or coke-oven gas. Input capacities range from 85,000 to 215,000 Btu per hr. Models are available with standard fan, squirrel-cage blower for short duct runs, or without blower for use directly in air-conditioning duct systems.

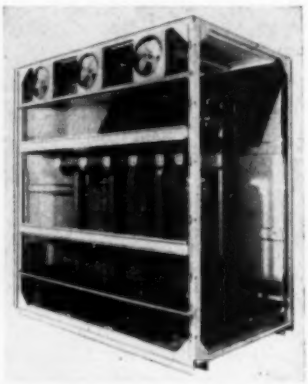


Centrifugal pumps are for sanitary service

E12 Corrosion-resistant sanitary and industrial centrifugal pumps, developed by Tri-Clover Machine Co., are available with special seals to meet practically every requirement. Units have capacities up to 1250 gpm. Heads are to 250 ft at zero gpm. Screw type impellers with sanitary impeller clips, inert carbon seals which are easily removed for cleaning, lightweight heads with a minimum of parts, and a special casing construction to permit fast assembly and disassembly, are among the features listed in a catalog.

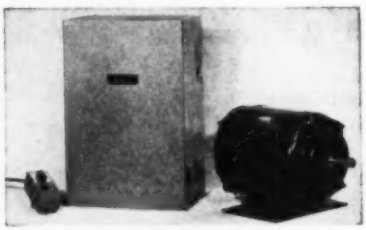
Television camera features miniature size

E13 Simplified operation is featured in a portable television camera unit, the Tel-Eye, developed by the Television Transmitter Div. of Allen B. Du Mont Laboratories, Inc. For closed-circuit television, it can be used with standard VHF receivers by simply plugging into a standard wall socket and attaching the output cable to the receiver. It will feed multiple receivers at distances up to 2000 ft. The unit is described as being a complete camera chain, with all associated power, synchronizing, RF, monitoring, and output equipment. The camera itself is about the size of a portable typewriter case.



Transformer takes overloads for extended periods

E14 To take overloads for longer periods of time, Marcus Transformer Co. has designed a dual-rated, dry-type heat proof insulated transformer. One rating covers its operation when naturally cooled. When heat reaches a certain level, a thermostat in the coils activates blowers mounted in the housing, thus providing forced air cooling that automatically increases the unit's rating by 33⅓ per cent. Ratings are from 100 to 3000 kva in voltages to 15,000 v.



Motor control system incorporates improved design

E15 The Servospeed Div. of Electro-Devices, Inc., reports many design improvements in their electronic variable speed motor control systems.

(Continued on page 14)

NOTE—Each new product item has a key number for your convenience in asking for additional, detailed information. Insert this number on return post card on page 99.

JENKINS PRACTICAL PIPING LAYOUTS

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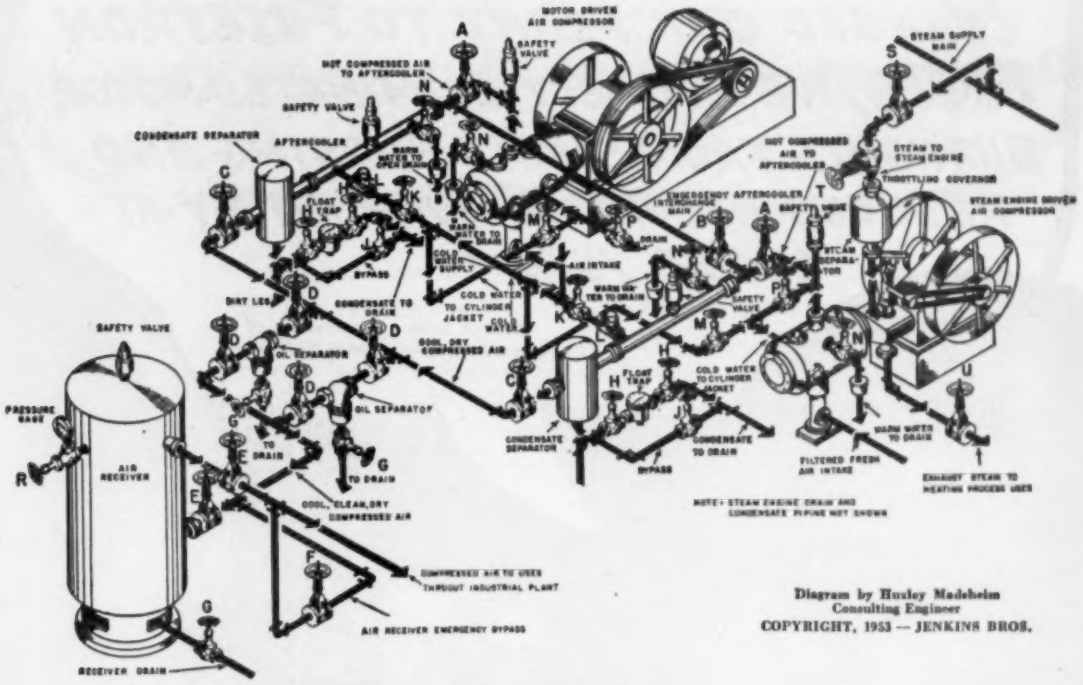

Diagram by Huxley Madeheim
Consulting Engineer
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VALVE RECOMMENDATIONS
Send for details of Jenkins Valves to suit varying conditions.

Code	Quan.	Jenkins Valves	Service
A	2	Fig. 651-A I.B.B.M. Gate	Compression Discharge Shutoff
B	1	Fig. 651-A I.B.B.M. Gate	Emergency Changeover Line
C	2	Fig. 651-A I.B.B.M. Gate	After Cooler Shutoff
D	4	Fig. 651-A I.B.B.M. Gate	Oil Separator Shutoff
E	2	Fig. 651-A I.B.B.M. Gate	Air Receiver Shutoff
F	1	Fig. 651-A I.B.B.M. Gate	Air Receiver Shutoff
G	3	Fig. 106-A Bronze Globe	Drain Line
H	4	Fig. 930 Bronze Globe	Trap Shutoff
J	2	Fig. 930 Bronze Globe	Trap By Pass
K	2	Fig. 106-A Bronze Globe	Cold Water Control
L	2	Fig. 352 Swing Check	Prevent Backflow
M	2	Fig. 106-A Bronze Globe	Cold Water Control
N	4	Fig. 106-A Bronze Globe	Drain Shutoff
P	2	Fig. 106-A Bronze Globe	Drain Shutoff
R	1	Fig. 744-G Needle Angle	Pressure Gage Control
S	1	Fig. 304 I.B.B.M. Gate	Steam Supply Line
T	1	Fig. 923 I.B.B.M. Globe	Steam Engine Shutoff
U	1	Fig. 651-A I.B.B.M. Gate	Engine Exhaust Shutoff

How to plan PIPING CONNECTIONS FOR AN INDUSTRIAL PLANT AIR COMPRESSOR

Compressed air is more economically supplied from a central installation in plants where demand is extensive. In such a system, the highest single pressure requirement in the plant determines the number of compression stages needed, and local pressure reducing stations meet the requirements of specific operations.

A single stage system is shown in this layout. Equipped with electric and steam driven compressors, this installation can develop 125 p.s.i. The former usually serves as a stand-by unit, but both can be used jointly for heavy load conditions.

The compressed air, after leaving the compressors, passes through a water-cooled after-cooler, which lowers air temperature and condenses moisture. The air then goes through oil separators and on into the air receiver, which decreases pressure pulsations and serves as a storage reservoir.

A capacity reduction device helps control load fluctuations in the constant-speed electrically driven compressor. In variable speed steam driven compressors, the throttling governor responds to load changes.

Consultation with accredited piping engineers and contractors is recommended when planning any major piping installation.

To save time, to simplify planning, to get all the advantages of Jenkins specialized valve engineering experience, select all the valves you need from the complete Jenkins line. It's your best assurance of lowest cost in the long run. Jenkins Bros., 100 Park Ave., New York 17.

Complete description and enlarged diagram of this layout free on request. Includes additional detailed information. Simply ask for Piping Layout No. 65.

JENKINS VALVES
LOOK FOR THE DIAMOND MARK
SINCE 1864

"TOM:—
IN THE FIRST YEAR AFTER WE CHANGED OUR PLANT TO FUSETRON FUSES, WE ENTIRELY ELIMINATED MOTOR BURNOUTS FROM SINGLE PHASING AND REDUCED ALL MOTOR BURNOUT BY AT LEAST 75%"

(Excerpt from a conversation of
Forrest Baumgardner with Tom Wier)

FORREST BAUMGARDNER, *Chief Electrician*,
Frank Wheatley Pump & Valve Mfr.
Tulsa, Oklahoma.

"FOREST:— DON'T FORGET FUSETRON FUSES DO MORE THAN PROTECT MOTORS — THEY PROVIDE 10 POINT PROTECTION!"

TOM WIER,
BUSS Fuseman,
covering Tulsa, Okla.

1 Protect against short-circuits.*

2 Protect against needless blows caused by harmless overloads.

3 Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.

4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5 Protect motors against burnout from overloading.

6 Protect motors against burnout due to single phasing.

7 Give DOUBLE burnout protection to large motors — without extra cost.

8 Make protection of small motors simple and inexpensive.

9 Protect against waste of space and money — permit use of proper size switches and panels.

10 Protect coils, transformers and solenoids against burnout.

* Fusetron Fuses have high interrupting capacity as shown by tests of the Electrical Testing Laboratories of New York.

Here's why FUSETRON Fuses give All Purpose protection...

A fuse link combined with a thermal cutout — the result, a fuse with tremendous time-lag and much less electrical resistance.

They have the same degree of Underwriters Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to same dimensions as ordinary fuses, FUSETRON FUSES fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere, both 250 and 600 volt types. Also in plug types for 125 volt circuits.

Their cost is surprisingly low.

FUSETRON is a trade mark of the Bussmann Mfg. Co.

Don't Risk Losses!

One **lost** motor . . .
One **needless** shutdown . . .
One **destroyed** switch or panel
One **burned out** solenoid . . .

May cost you far more than replacing every ordinary fuse with a Fusetron dual-element Fuse.

Bussmann Mfg. Co., University at Jefferson, St. Louis 7, Mo. (Division of McGraw Electric Co.)

Please send me complete facts about FUSETRON dual-element Fuses.

Name_____

Title_____

Company _____

Address _____

City & Zone_____ State_____ 553

new equipment

(Continued from page 10)

The units, up to 3 hp, now have special terminal block transformer construction, cabinet design for wall or bench mounting, and critical component plug-in assemblies. The motor series field is used as a torque signal source in a feedback circuit to provide constant system torque capability. Controlled acceleration on many models permits use with high initial loads. Manual speed selection at remote points is available, as well as many types of Automatic Servospeed systems for use in various industrial processes. Literature is available.

Electronic drives provide stepless adjustable speeds

E16 Reliance Electric & Engineering Co. announces design improvements in its electronic adjustable-speed drives from ¾ to 3 hp. The drives are a constant torque, variable-horsepower type which provide stepless adjustable speeds from a-c circuits. They operate at speeds from 270 to 2300 rpm, and as low as 75 rpm for setting-up operations, light loads, or intermittent duty. Components are a drive motor, control station, and control unit.

Proportioning pump design simplifies maintenance

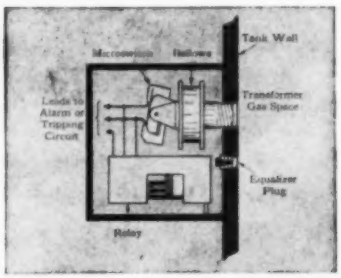
E18 Philadelphia Pump and Machinery Co. has reported several design improvements in their low-capacity, high pressure, reciprocating plunger, controlled capacity proportioning pump. The unit is constructed to allow removal of all moving parts without breaking piping connections. The packing gland is unusual in that it is open at both ends to simplify packing replacement and insure even take-up. The units can be used in single or multiple combinations. Capacities range from 5 cc per hr to 128 gph, with pressures to 20,000 psi.

TO REQUEST ADDITIONAL DATA

Insert "key" numbers on return post card found on page 99. Your requests will be handled promptly.

Additive regulates setting time of cement

E19 Flexrock Company's Building Maintenance Div. has developed a liquid chemical additive to make a fast-acting leak-stopper out of ordinary cement. Called Flextite, it regulates the setting time of Portland cement, making it possible to stop leaks almost instantly without removing hydrostatic pressure. It is said to be equally effective as a water resistant plaster coat to seal off seepage and exclude moisture, and for pointing up spalled areas or reforming exposed reinforcing bars or beams. The mortar also works on concrete, masonry, or brick surfaces.



Relay protects transformers from internal faults

E20 Westinghouse Electric Corp. has developed a sudden pressure relay that protects power transformers from internal faults. Operating on rate of change of gas pressure resulting from transformer oil breaking down, it is not affected by changes common to transformer operation. The unit is said to be very sensitive to small faults, and is quick to operate when large faults occur. Faults that produce rates of pressure rise above 10 to 15 psi per sec cause the relay to operate in 2 or 3 cycles. Rates of 40 psi per sec cause operation within ½ cycle.

Meter measures true mass rate of flow

E21 True mass rate of flow of anything that will flow or fall through a pipe is measured by a flow meter developed by Control Engineering Corp. The meter responds to pounds, and is reported to be totally

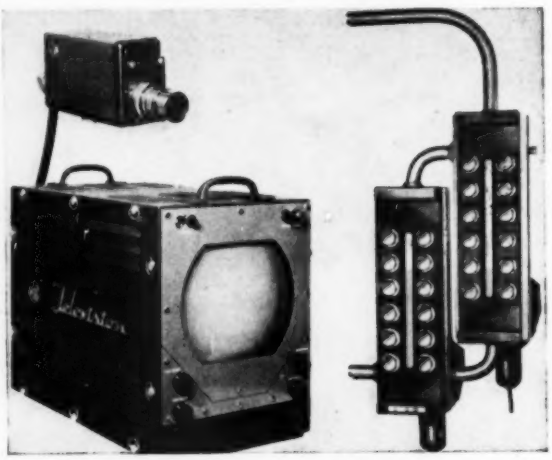
(Continued on page 20)

Industrial television permits observation of remote boiler gages

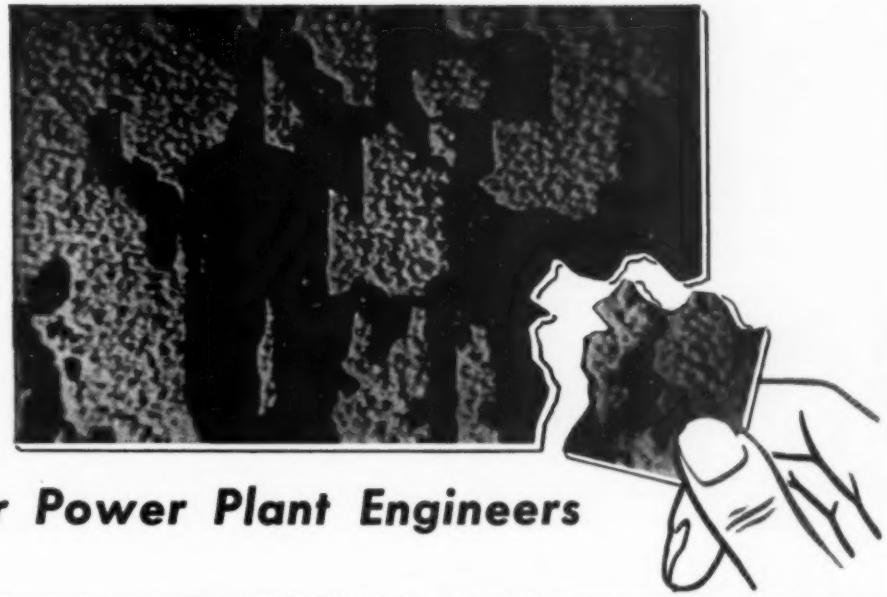
E17 Availability of closed-circuit television for observation of remote boiler water gages has been announced by Yarnall-Waring Co. An arrangement has been made with Radio Corporation of America to apply their industrial television equipment to installations of Yarway pressure sealed flat glass gages, thus permitting "live" gage readings at any convenient location in the boiler plant.

Television equipment consists of a small, light-weight camera connected to the viewing monitor by a single cable. The recent development of a small, simplified tube is reported to permit a camera approximating the size of a 16 mm home movie camera. A special camera base also is provided to furnish proper lighting of the gages.

Gage glass inserts are described as a pressure-sealed "floating assembly type." Greater flexibility is gained by using two independent inserts, and by interconnecting expansion loops. Illuminators are the Yarway type M, which produces a brilliant point of light at the meniscus of the water level. They are said to be especially effective in penetrating deposits on the gage glass and dust particles in the air.



JIG-SAW PUZZLE



for Power Plant Engineers

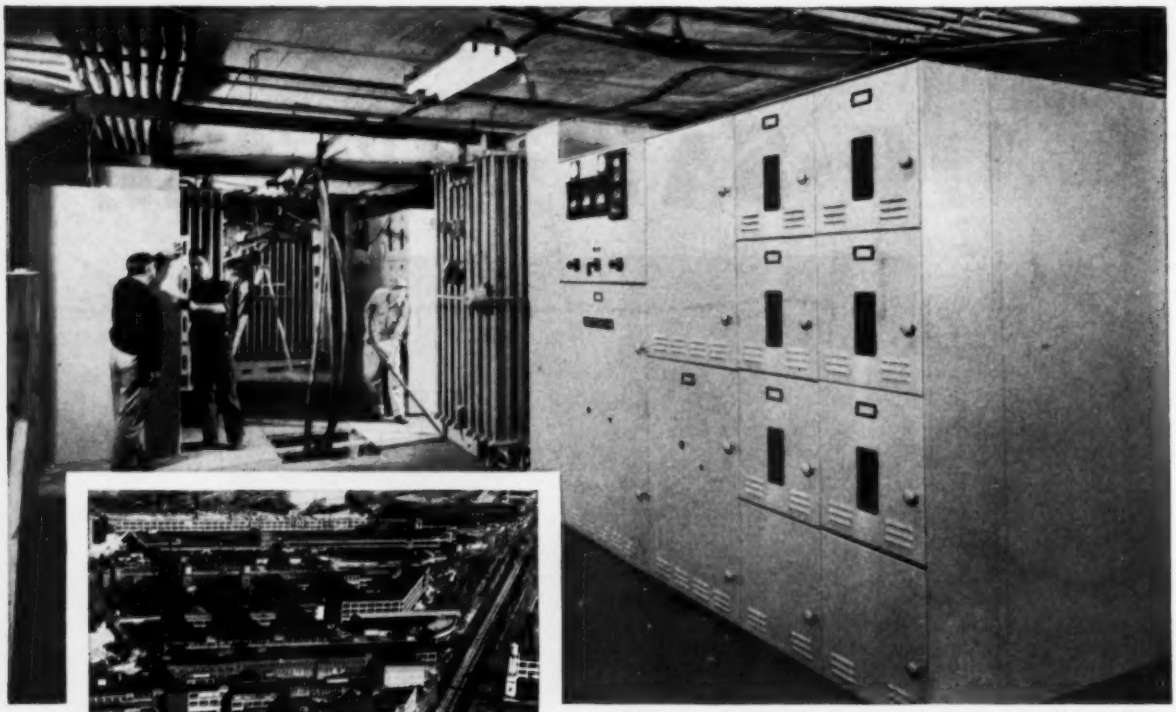
MAGNESIUM scale, magnified fifty times, can look like the jig-saw puzzle it often represents to plant engineers when it begins to affect boiler operation. Quick solution for this and any other scaling or corrosion problem is The Nalco System for your plant. High quality water treating chemicals, plus expert field and laboratory surveillance assure continuously successful results—now, and in the years to come, as long time Nalco customers will affirm. Write for your Nalco Water Treatment Survey today.

NEW DATA ON SCALE IN HIGH PRESSURE BOILERS

Reprints of "Experimental Studies of Boiler Scale at 2,500 p.s.i.," a paper presented at the 1950 Water Conference of the Engineer's Society of Western Pennsylvania, are available free upon request to Nalco. Article includes numerous photos of scale formations on test boiler tubes, and charts showing results of various water treatment methods.

NATIONAL ALUMINATE CORPORATION
6218 W. 66th Place • Chicago 38, Illinois
Canadian inquiries should be addressed to Alchem Limited, Burlington, Ontario

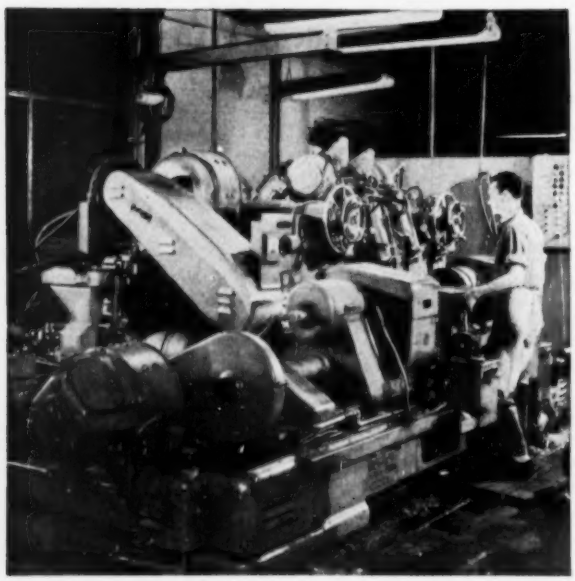
THE *Nalco* **SYSTEM . . . Serving Industry through Practical Applied Science**



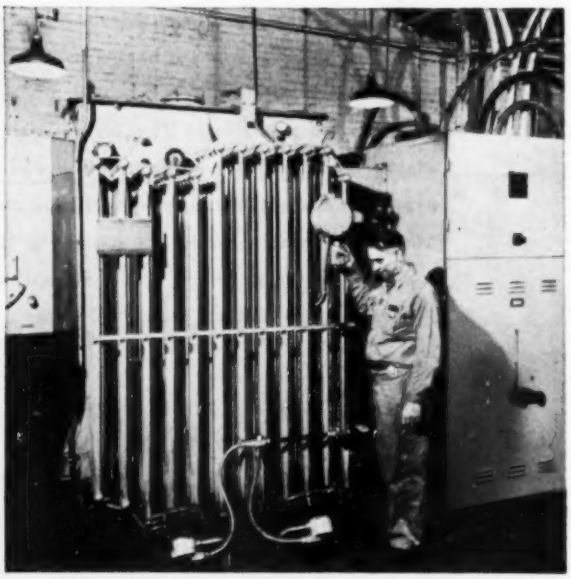
Willys-Overland plant, covering 103 acres (at left) in Toledo, O., adds five new G-E unit substations to expand simply and easily its radial distribution system. Total plant capacity is now 26,000 kva. Three of the 1,500-kva subs (above), with two others, furnish power to aircraft landing gear division.

AT WILLYS-OVERLAND—

One of nation's first load-center

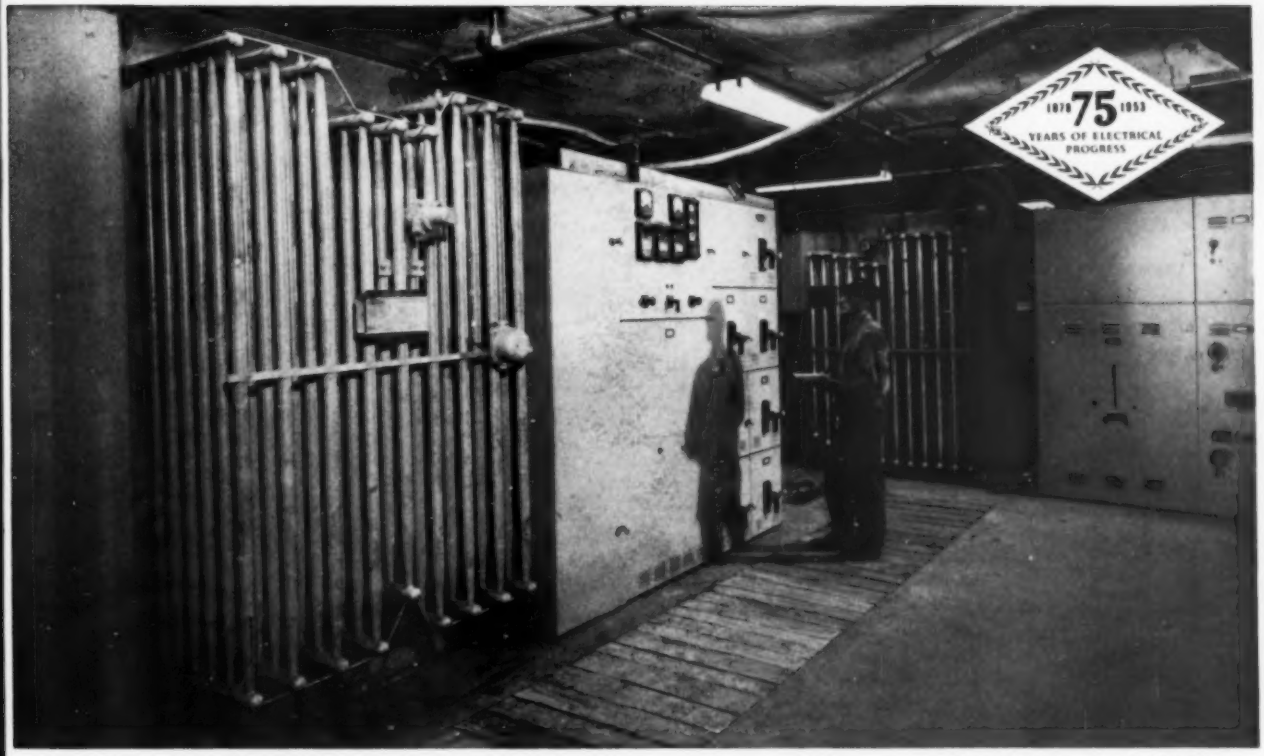


Grinder for crankshaft pin bearings is powered by a G-E unit substation, 4160-volt to 440-volt, which is located just beyond screen at left, adjacent to the load area.



Installed since 1945, when original system was expanded, G-E unit substation, with Pyranol* transformer, has been operating 24 hours a day, 5 days a week, with low maintenance cost.

*Reg. Trade-mark of General Electric Co.



New load-center units, are added to system which has operated for 13 years without power failure. Addition of new substations, like the two new 1,500-kva units above, does not alter over-all system, provides high degree of flexibility to handle shifts in plant loads. Unit subs, used as building blocks, can be placed wherever needed.

systems: Never a power failure!

G-E radial distribution system, installed in 1939, easily expanded to 26,000 KVA for increased plant loads

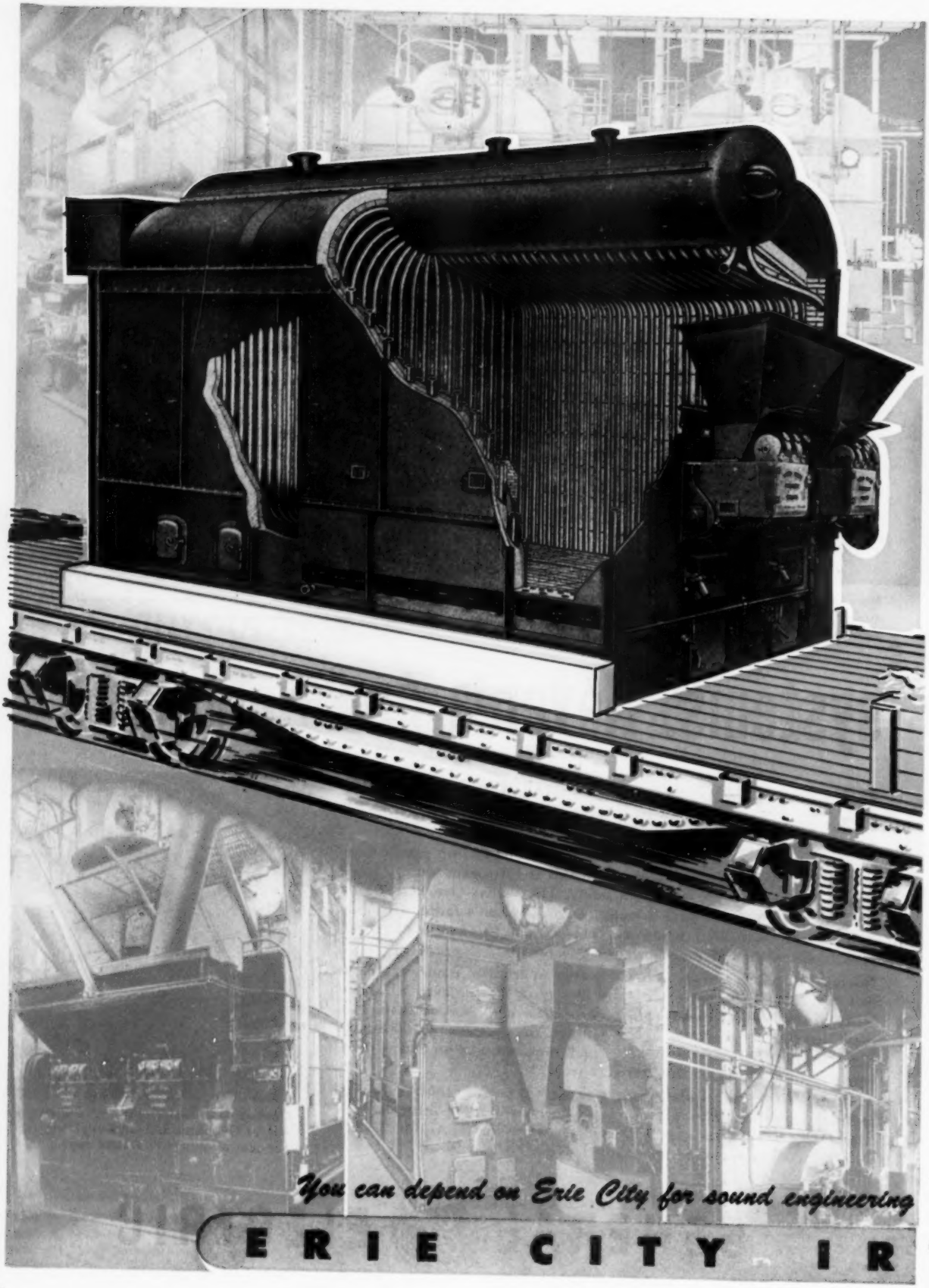
Flexibility in reliable power distribution for stepped-up production of Jeeps . . . quick, easy power expansion at little expense . . . low-cost maintenance with maximum safety. The Willys-Overland Company in Toledo found these advantages of its plant's radial distribution system multiplied when five new G-E 1,500-kva load-center substations were added recently for greater plant capacity.

During the past 13 years of trouble-free operation, engineers have had first-hand experience with the low cost, simplicity, and reliability of the radial system. A G-E outdoor unit substation furnishes plant power, steps down utility voltage to a usable 4,160 volts. Eighteen unit substations handle load requirements in more than two-score buildings on the 103-acre tract.

This installation is just one example of the way G-E engineering helps industry meet demands for more power. For further information, contact your G-E sales representative, or write for GEA-3592. General Electric Company, Schenectady 5, New York. 681-1

Outdoor G-E master unit substation, plus an indoor G-E station, furnishes power for 90 per cent of Willys-Overland capacity.

GENERAL ELECTRIC


You can depend on Erie City for sound engineering
ERIE CITY IR

Here's Another

ERIE CITY VL STEAM GENERATOR

This one, fired by the Erie City Dumping Grate Spreader Stoker. Erie City VL's by the hundreds are serving a broad cross section of small to large steam users. These completely factory-assembled or field erected steam generators incorporate a 2-drum boiler and integral water cooled furnace for any mechanical firing method. We draw upon a 50 year experience with 2-drum boilers and a pioneering application of water wall design that keeps refractory maintenance to a minimum.

Only clean water can enter the integral water wall circulation. VL's are the most accessible boilers of this type—easy to keep clean and at top efficiency. Hospitals, Schools, Institutions, Dairies, Laundries, Industries and Process Plants use and repeat on VL's.

Stoker and 300 hp. VL boiler are shown combined but are shipped as two units.

A Few of the Hundreds of Erie City VL Users

BORDEN CO.
DAIRYMAN'S LEAGUE
ARMOUR & CO.
KRAFT FOODS CO.
GENERAL MILLS CO.
REPUBLIC STEEL CORP.
BORG WARNER CORP.
ALUMINUM CO. OF AMERICA
GENERAL ELECTRIC CO.
UNION PACIFIC R. R. CO.
HERCULES POWDER CO.
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ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

Get the **COMPLETE STORY . . .**

on this modern 2-DRUM Steam Generator for all mechanical firing methods.

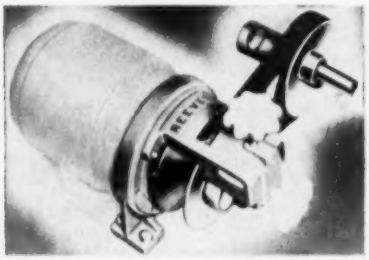
Ask for **SB-43D**

ERIE CITY IRON WORKS • *Erie, Pa.*

new equipment

(Continued from page 14)

insensitive to volume. Accuracy is said to be independent of temperature, pressure, viscosity, compressibility, or external accelerations.



Variable speed drive features flexibility

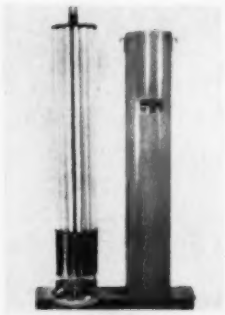
E22 Unusual flexibility of operation is combined with low unit cost in the Flexi-Speed variable speed drive, according to the manufacturer, Reeves Pulley Co. Units can be mounted in almost any position around the driven equipment, may drive in any direction, and can deliver any desired speed within a ratio of 8 to 1. The driven shaft can be located anywhere around the motor shaft, and the speed control handwheel can be located parallel to or in any of eight positions perpendicular to the motor shaft. Units with capacities of ½, ¾, and 1 hp are listed in an available bulletin.

Duct insulation simplifies installation

E23 Owens-Corning Fiberglas Corp. has developed a Fiberglas insulating product, known as Flexible Duct Liner, for lining the interior of air conditioning and warm air ducts. In addition to providing thermal insulation, it is said to have a high noise reduction efficiency. It also is said to permit metal surfaces to act as vapor barriers to prevent condensation. Its flexibility permits installation on metal sheets before they are formed. A fire-safe neoprene coating is used to prevent erosion and to reduce friction. The product is described in a data sheet.

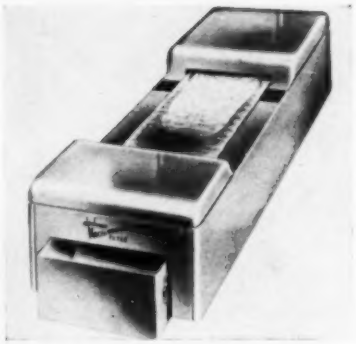
TO REQUEST ADDITIONAL DATA

Insert "key" numbers on return post card found on page 99. Your requests will be handled promptly.



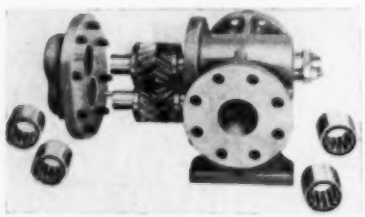
Unit dehydrates and filters compressed air

E25 To provide economy of operation, a recently developed disposable filter cartridge is incorporated in the Model A-100-D Condensifilter, a unit to filter and dehydrate compressed air. According to the manufacturer, Hankison Corp., the filter will operate satisfactorily for five to six months under normal working conditions. It is said to provide maximum heat exchange area for cooling the air traveling through the condensing section, thus removing water and oil in both entrained and vaporized states. A snap-action, spring loaded trap is provided. Technical data is contained in a bulletin.



Filter provides automatic self-cleaning operation

E26 Automatic, continuous filtration of water soluble coolants for individual grinders, hones, and other machine tools is provided by a constant vacuum, endless belt filter developed by the Industrial Filtration Div. of U. S. Hoffman Machinery Corp. Called the Vacu-matic Filter, it provides automatic, self-cleaning operation, keeps coolant cool, and delivers de-watered sludge for easy disposal. Two models, providing flow rates of 20 and 40 gpm, are listed in an available bulletin.



Rotary gear pump features simplified design

E27 To provide high quality at low cost, Sier-Bath Gear & Pump Co., Inc., has simplified the design of their rotary gear pumps. Primarily for positive displacement of lubricating liquids, the Hydrex pump will handle fluids and semi-fluids of 32 to 250,000

(Continued on page 26)

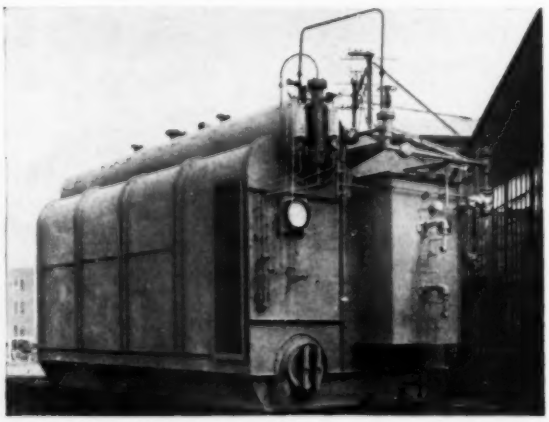
Package water tube boiler features longitudinal firing

E24 Side wall headers are eliminated in a package, two-drum, longitudinally fired, water tube boiler developed by The Henry Vogt Machine Co. Since the furnace is formed by equally spaced U-shaped tubes which are rolled into the steam and mud drums, side wall headers are not required. A 36 in. steam drum and 24 in. mud drum are standard for all units.

Enclosed in an insulated sectional steel casing, the unit requires only a foundation and the necessary piping, duct, and electrical connections to complete the installation.

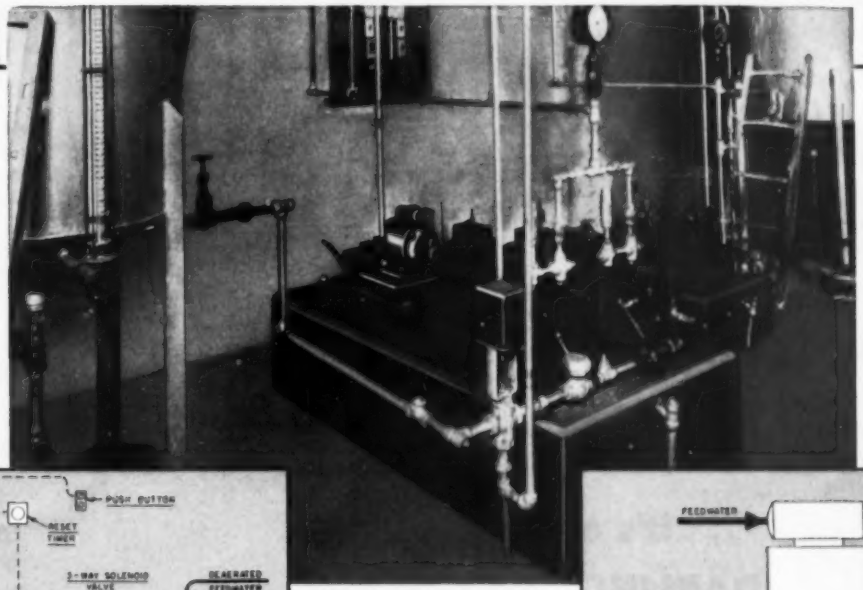
Both induced draft and forced draft designs are available. Natural gas, a variety of fuel oils, or a combination of both oil and gas can be burned. Capacities up to 30,000 lb per hr are available in a wide range of pressures. The boiler is designed to permit the use of soot blowers and superheaters when required.

According to the manufacturer, the units are suitable for either indoor or outdoor installation. Its compact design permits shipment by either rail or truck.

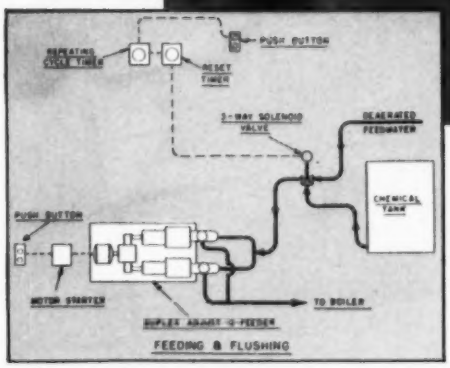


Here's the combination

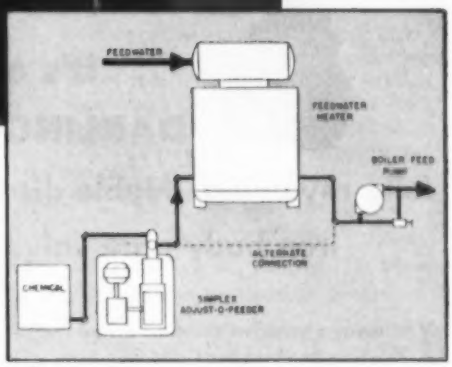
TO TREAT YOUR BOILERS RIGHT



%PROPORTIONEERS% equipment feeding sodium phosphate and sodium sulphite in the modern power plant of River Raisin Paper Co. at Monroe, Mich. Photo courtesy Pulp & Paper.



TO PREVENT CORROSION AND SCALE. *Continuous or intermittent* phosphate feed direct to the boiler drum.



TO ELIMINATE OXYGEN IN FEEDWATER. *Constant Rate* sodium sulphite feed to the deaerater or feedwater heater.

%Proportioneers% Chemical Treating Systems automatically maintain the proper chemical feed for correct boiler water conditions. They reduce boiler maintenance, minimize operator responsibility, and provide positive control of chemical application. We offer standardized equipment and methods for time or flow-responsive control, including chemical feeders, special dissolving tanks, alarm systems, relief valves, automatic feeding and flushing valves, control panels, etc., to maintain top efficiency in power plant operation.

Let %Proportioneers% assume full responsibility for *your* complete chemical feeding system. Write today for Brochure SM-9020.

% PROPORTIONEERS, INC. %

Write to %PROPORTIONEERS, INC.%, 357 Harris Ave., Providence 1, R. I.

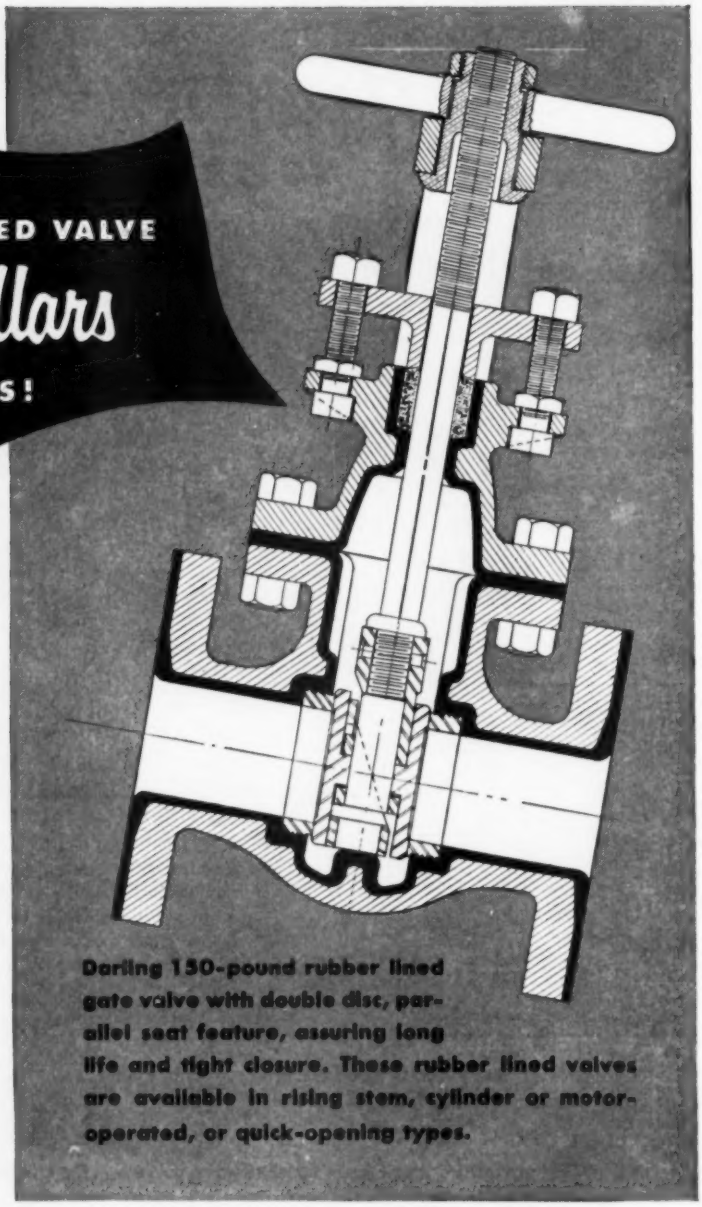
Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

HOW THIS RUBBER LINED VALVE

stretches dollars

IN CORROSIVE SERVICES!

it's a DARLING fully revolving double disc iron body gate valve



Darling 150-pound rubber lined gate valve with double disc, parallel seat feature, assuring long life and tight closure. These rubber lined valves are available in rising stem, cylinder or motor-operated, or quick-opening types.

IN many corrosive services up to 180° F, Darling hard rubber lined iron body gate valves are taking the place of costly special alloy valves . . . saving plenty of dollars!

And when it comes to year-in, year-out behavior, they can't be beat! A proved bonding technique permanently prevents separation of the hard rubber lining from the valve body. All interior working parts are made of alloys suitable for the corrosive conditions involved.

Equally important, these valves feature Darling's fully revolving double disc parallel seat principle. This, combined with the equalizing wedges, means easy, *tight* closure even if seats are not parallel due to line stresses. It means *uniform* distribution of wear for prolonged life with minimum maintenance cost.

SEND FOR DATA. A bulletin covering Darling rubber lined *gate* and *check* valves is yours for the asking. In addition, Darling parallel seat revolving disc gate valves are available in a wide range of sizes and constructions for all kinds of normal and unusual service, and for pressures up to 1500 pounds. We'll gladly furnish specific recommendations on the proper valves for your particular service.

DARLING VALVE & MANUFACTURING CO.

Williamsport 9, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario

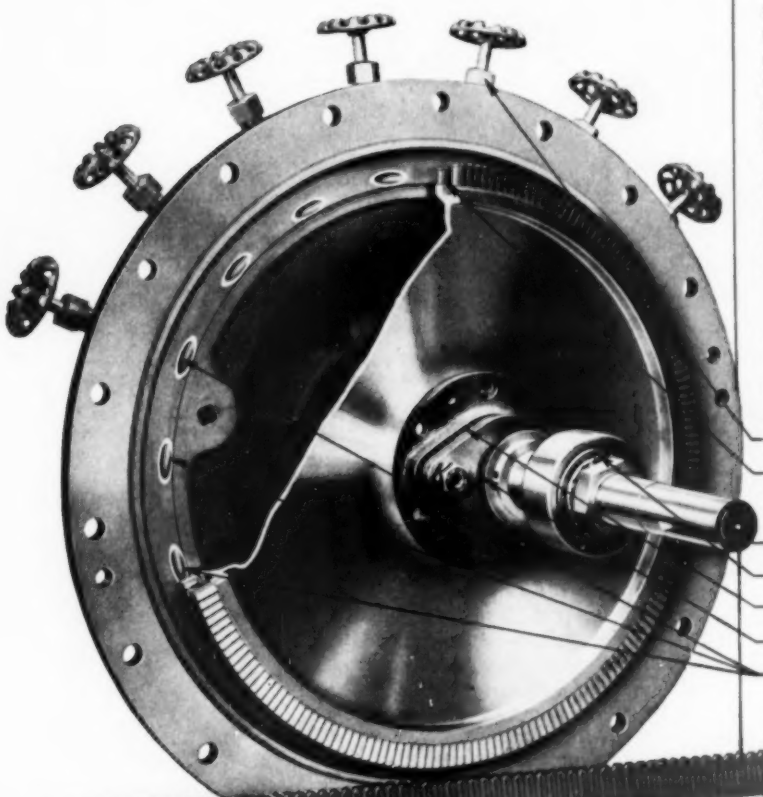
DARLING VALVES

FOR PLUS VALUES, JOB-PROVED AGAIN AND AGAIN

No other steam turbine offers you

SUCH VERSATILE STEAM NOZZLE CONTROL

The larger number of hand valves you see on a Coppus Steam Turbine promises you greater operating economy. At least 60% of the steam nozzles can be individually controlled to give maximum steam pressure in steam chest . . . a guarantee of best water rates at any load. Maintenance economy, too, is assured by the hard chromium plating of the shaft at the stuffing box. It provides the best possible smooth, non-corrosive surface for packing rings.



7 hand valves for efficient partial load operation, (20" turbine shown)

2 row velocity-stage turbine wheel with stainless steel turbine buckets — statically and dynamically balanced

30-40 carbon steel shaft

Oversized double row deep grooved ball bearing

Stuffing box with metallic packing ring

Heavy chrome plating of shaft through stuffing box

3 nozzles always open

Coppus Steam Turbines, Type TF, driving chemical transfer pumps at Celanese Corporation of America's Chemcel Plant

Coppus Steam Turbines ranging from 150 hp down to fractional in 6 frame sizes

MAKE TURBINE DOLLARS GO FARTHER

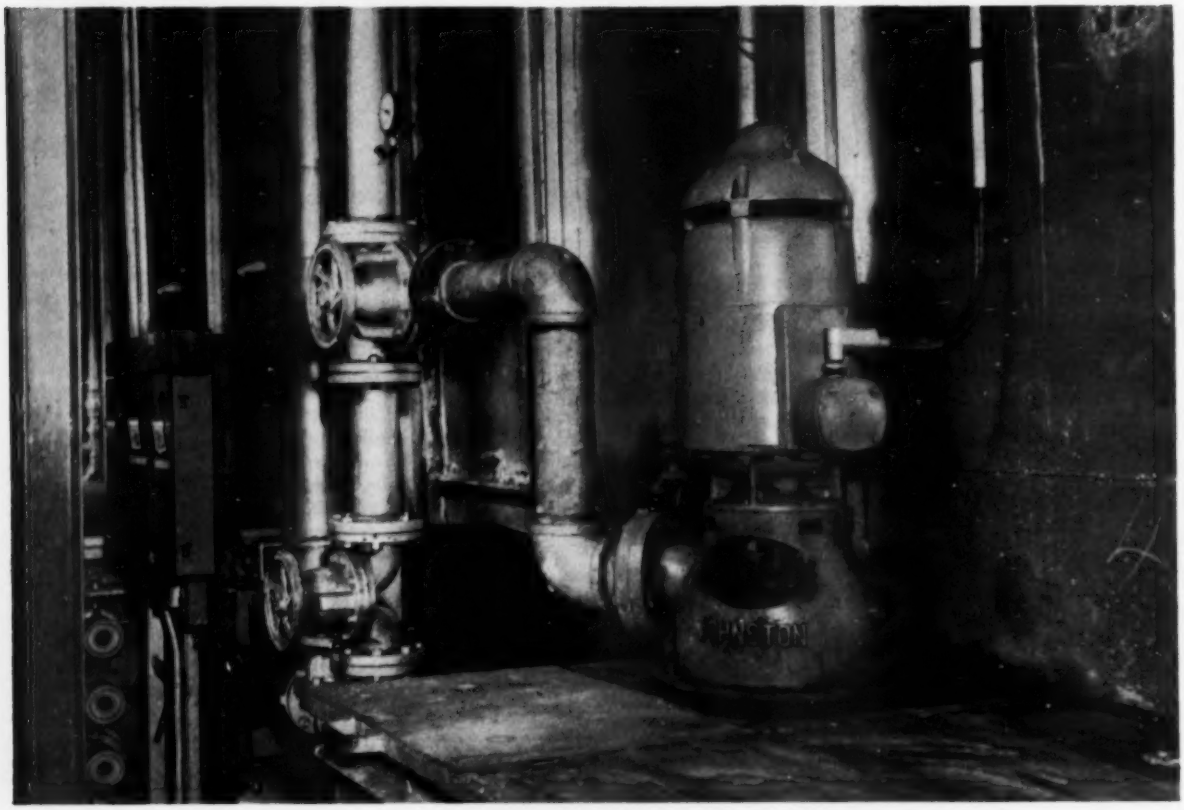
Why waste money buying turbines with higher horsepower ratings than you need? The higher the horsepower rating, the higher the price. Save money by selecting the Coppus Turbine size closest to your requirements from 150 hp down to fractional. And when you do, you save operating and maintenance costs, too. That's what these other Coppus features are designed to do: exclusive pilot operated excess speed safety trip supplementing constant speed governor; choice of metallic or carbon ring packing assemblies. Designs available for back pressures up to 75 pounds; replaceable cartridge type bearing housings. For full details . . .

WRITE FOR BULLETIN 135

COPPUS ENGINEERING CORP., 185 Park Avenue, Worcester 2, Mass. Sales offices in THOMAS' REGISTER.

COPPUS "BLUE RIBBON" TURBINES

Critical jobs are routine for Johnston!



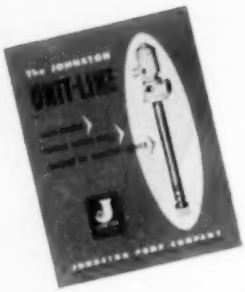
PUMPING BONDERITE, FOR EXAMPLE . . .

In the Los Angeles assembly plant of one of the automotive Big Three, Bonderite is sprayed on sheet metal body parts before painting. Bonderite is *really tough* on pumps, because of its highly abrasive and corrosive characteristics.

In fact, many pumping units put on this job have worn out completely in a few weeks. SEVEN MONTHS ago the Johnston Pump pictured above was installed and *is still operating without a shut-down.*

Here are the specifications of the Johnston unit designed for this job: 7½ horsepower; 1760 r.p.m.; 40 feet total head; 500 g.p.m.; 2 stage, 8 inch pump driven by a totally enclosed, fan-cooled, hollow shaft electric motor. The shaft is enclosed in a steel tube and the bowls, impellers and discharge head are of uncoated cast iron.

This is another example of how Johnston engineering is solving pumping problems in industry after industry. Why not let us consult with you on YOUR particular needs?



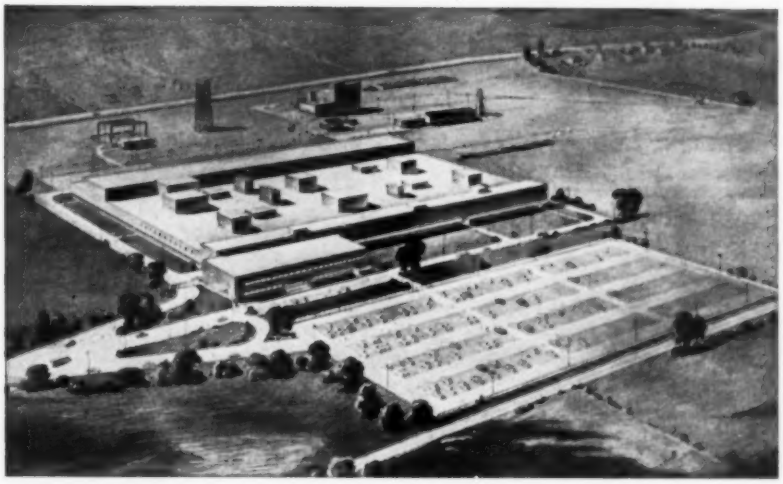
Send today for your free copy of the new bulletin about close-coupled industrial pumps. Ask for Bulletin H-53.

JOHNSTON
VERTICAL PUMPS

JOHNSTON PUMP COMPANY

3272 EAST FOOTHILL BLVD., PASADENA 19, CALIFORNIA

TWO WICKES STEAM GENERATORS will help heat the CATERPILLAR TRACTOR CO.'s new plant at York, Pa.



CONTRACTORS: Consolidated Engineering Company Inc., Baltimore, Md.
CONSULTING ENGINEERS: Whitman, Requardt & Associates, Baltimore, Md.

The Caterpillar Tractor Co., one of the world's largest manufacturers of earth moving equipment, will shortly open their new York, Pa. plant where several hundred men will turn out track assemblies for world famous Caterpillar D6, D7 and D8 Tractors. In this modern manufacturing facility, Caterpillar has installed two 80,000 lb. WICKES steam generators to obtain efficient, economical heat throughout the 360,000 sq. ft. structure. These Type R 2-drum WICKES boilers have a design pressure of 200 psi. and are equipped with economizers and spreader stokers. WICKES can fill your requirements for steam generators up to 250,000 lbs. per hour and 1000 psi. – all types of multiple drum boilers, adaptable to any standard method of firing: oil, gas, underfeed or spreader stoker. Consult your nearest WICKES representative or write us today for descriptive literature.

145

WICKES

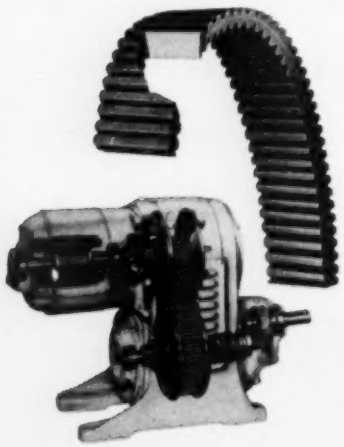
THE WICKES BOILER CO., SAGINAW, MICHIGAN • DIVISION OF THE WICKES CORPORATION

RECOGNIZED QUALITY SINCE 1854 • SALES OFFICES: Atlanta • Boston • Buffalo • Chicago • Cincinnati • Cleveland • Denver • Greensboro, N.C. Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • Pittsburgh • Portland, Ore. • Saginaw • Springfield, Ill. • Tampa Tulsa • Washington, D. C.

new equipment

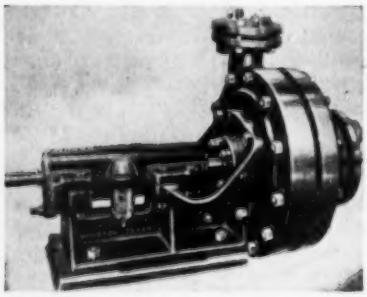
(Continued from page 20)

SSU. Capacities are listed up to 500 gpm at 300 psi for continuous duty, or 500 psi for intermittent service.



Double-ribbed V-belt permits compact design

E28 Variable speed motors, manufactured by U. S. Electrical Motors, Inc., now incorporate a double-ribbed V-belt which is reported to reduce internal friction and permit greater flexibility. Higher speeds and smaller diameters can be combined to permit designs having higher horsepower within a smaller space. The Varibelt is described as having high resistance to heat, oil, and grease, and is protected from drippings by complete enclosure. Additional information is contained in a 16-page bulletin.



Plastic used in construction of centrifugal pump

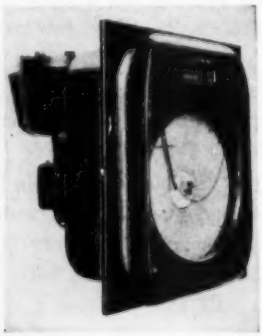
E29 For handling acids, bases, salts, solvents, and many other chemicals, the Centrifugal Pump Div. of Mission Manufacturing Co. is constructing a centrifugal pump of solid plastic. In addition to a plastic casing and semi-open impeller, the design is said to contain many important features, including a long heavy bearing housing to insure alignment, and a specially designed slinger and housing cap to protect bearings from contamination. The unit is made with 3 in. suction and 2 in. discharge size only. Operating at 1750 rpm, it will handle capacities to 300 gpm and heads to 110 ft. It is suitable for temperatures up to 265 F. A bulletin is available.

Exhaust head contains no moving parts

E30 No moving parts or filters are used in an exhaust head developed by the V. D. Anderson Co. to clean steam and vapors discharged to the atmosphere. The unit is said to be particularly advantageous for removing such nuisance particles as oil and process liquors which attack machinery, near-by buildings, and create a public nuisance. A stationary centrifugal element is used.

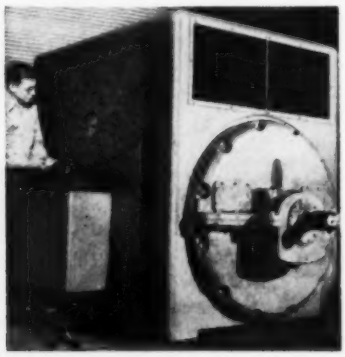
TO REQUEST ADDITIONAL DATA

Insert "key" numbers on return post card found on page 99. Your requests will be handled promptly.



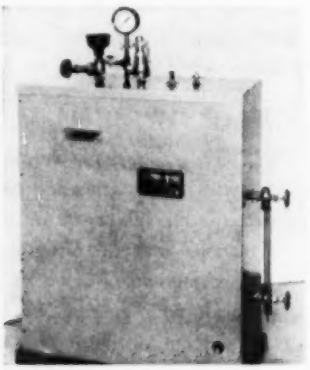
Meter incorporates magnetic coupling

E31 Penn Industrial Instrument Corp. has designed a mechanical flow and level meter using a magnetic coupling to connect the manometer float with external metering parts. Known as the Magna-Clutch, it incorporates a sealed mercury manometer. Because no leakage is possible, it is recommended for toxic, corrosive, or inflammable fluids. Advantages include low maintenance cost and accessibility to the manometer for inspection and cleaning. Seven interchangeable range tubes from 20 to 750 in. of water are available. Manometers for 4 to 8 in. of water also are available. Recording, integrating, pneumatic transmitting, and controlling types for static pressures to 2500 psi are described in a bulletin.



Feed pump motor permits closer mounting

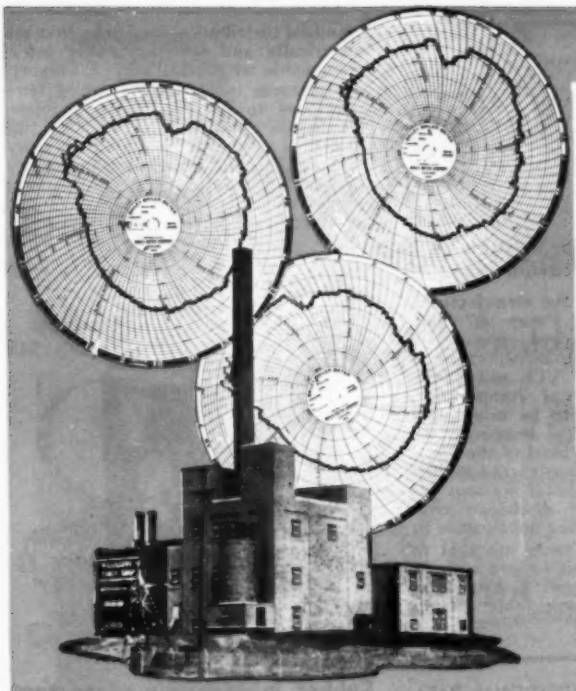
E32 Cubical design, a special high-speed rotor, an improved ventilation system, and quieter operation are listed as the principal features for a boiler feed pump motor developed by General Electric Company's Medium Induction Motor Dept. To permit adjacent units to be mounted closer together without harmful recirculation, hot air is discharged away from nearby motors. Quieter operation is said to be the result of a large air discharge chamber, the baffling effect of louvered inlets and outlets, and a special finish which the high-speed rotor receives after grinding. Units of 1000 hp, and larger, are described in a 4-page folder.



Electric boiler offers important size reductions

E33 Livingstone Engineering Co. has designed an electrode steam generator, the Speedylectric series ABC, to operate on various voltages at constant amperage. The kw rating, heating capacity, and steam output are said

(Continued on page 28)



CONSISTENT EFFICIENCY

AT ALL LOADS

with Detroit Stokers at Mississippi Valley Public Service Company, Winona, Minnesota

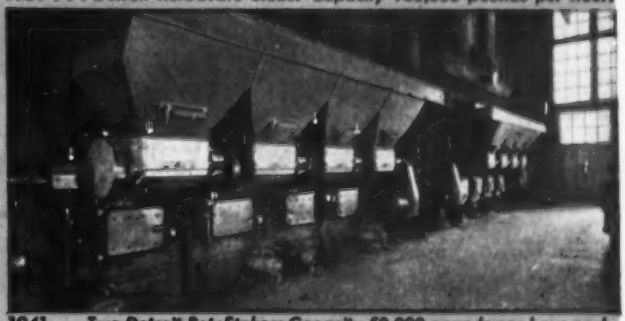
To meet increased demands for power, Mississippi Valley Public Service Company of Winona, Minnesota, added a new 160,000 pound per hour unit in 1951. It was only natural that a Detroit RotoGrate Stoker was selected for this larger boiler after their successful operation of 50,000 pound capacity Detroit RotoStokers installed ten years previously.

The new Rotograte has proved thoroughly dependable. It is efficient at any load and fluctuations are handled without appreciable pressure drop.

Detroit Spreader Stokers have built up a reputation for high efficiency and exceptional dependability since first introduced in 1931. They burn any Bituminous coal or Lignite without special preparation. Little power is required for operation . . . maintenance costs are low . . . availability is high.

There is a type and size Detroit Stoker to save you money and improve your operation. Let us make recommendations—no obligation.

1951 . . . Detroit RotoGrate Stoker Capacity 160,000 pounds per hour.



1941 . . . Two Detroit RotoStokers Capacity 50,000 pounds per hour each.

DETROIT STOKER COMPANY

GENERAL MOTORS BUILDING • DETROIT 2, MICHIGAN

Works at Monroe, Michigan • District Offices in Principal Cities

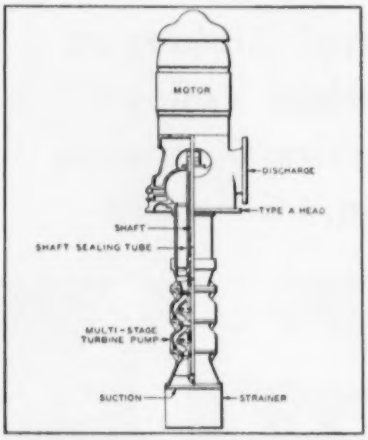
DETROIT SINCE 1898 STOKERS

5154

new equipment

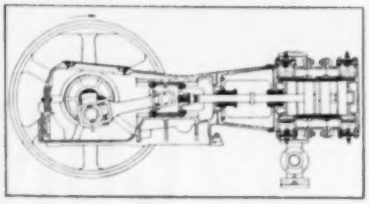
(Continued from page 26)

to vary in proportion to the voltage. Boilers are designed for 220, 440, or 550 v operation, but offer important advantages when used with 440 or 550 v supply. Units operating on 440 v require less than ½ sq ft of floor space per boiler hp. The boilers are said to operate at 98 per cent efficiency with unity power factor. Units are offered in sizes to 60 bhp and pressures to 500 psi.



Vertical pump design eliminates packing glands

E34 Vertical turbine wet pit pumps that can be ordered by a model number from simple head-capacity selection charts are being manufactured by Johnston Pump Co. Known as Unit-Line, they are pre-engineered for wet pit or tank operation, and are shipped completely assembled and crated. An interesting feature is the elimination of packing glands. Capacities range from 20 to 2000 gpm at heads from 10 to 550 ft. Electric motors from ¼ to 200 hp are available in drip proof, totally enclosed, or explosion proof frames. Literature is available.



Compressor design eliminates air cylinder lubrication

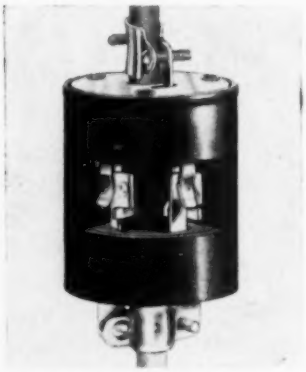
E36 According to the manufacturer, Pennsylvania Pump & Compressor Co., steel-backed carbon cylinder liners are being incorporated in construction of Class ATL and ATCL Oilfreair and Oilfregas compressors. Maintenance is said to be minimized, and life expectancy is improved. In addition, the cylinder head of the Class ATL unit has been constructed in segments to permit removal without interrupting intake or discharge connections. By eliminating lubrication in the air cylinder, the units are said to provide compressed air or gas entirely free of oil or oily vapor. Construction is described in a 6-page folder.

TO REQUEST ADDITIONAL DATA

Insert "key" numbers on return post card found on page 99. Your requests will be handled promptly.

Fuse links prevent damage

E37 General Electric Company's Distribution Transformer Dept. has announced a new line of EEI-NEMA standard distribution fuse links that are electrically and mechanically interchangeable with other makes. Important features include low melting temperatures to prevent cutout damage, continuous current carrying capabilities in excess of ratings, and long auxiliary tubes to permit better full-range operation of any fuse cutout. Time-current curves, coordination charts, and conversion procedures are available.



Rubber interlocking connectors for heavy industrial use

E38 Rodale Manufacturing Co., Inc. reports that a recently developed locking device has made possible the first all-rubber connector specifically designed for heavy industrial use. Cataloged No. 2209, it is interchangeable with all other interlocking makes. Special lugs at the tips of the female contacts engage and support the male blades, thus establishing a strain-proof, double-locked connection. It is offered for 2, 3, or 4 wire applications, and is rated for 10 and 20 amp service.

Unit automatically loads heat treating furnaces

E39 To increase and improve production, and at the same time reduce labor costs, Michigan Crane & Conveyor Co. has designed a heat treating furnace loader to automatically remove material from a hopper and discharge it in metered quantities into

(Continued on page 30)

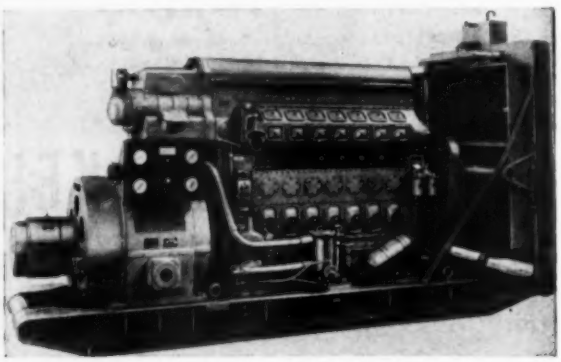
Diesel features opposed piston design

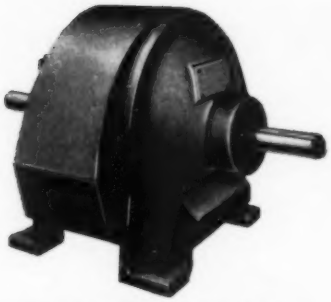
E35 To meet the demand for a compact, heavy-duty diesel for stationary, marine, and railroad applications, Fairbanks, Morse & Co. has developed an opposed piston engine in the 225 to 750 hp range.

It has a 5¼ in. bore and 7¼ in. stroke, and is rated at 75 hp per cylinder at 1200 rpm. The manufacturer emphasizes that it is designed for continuous heavy duty service despite its low weight.

Units can be equipped to operate as oil-burning diesels, as dual-fuel, or as spark ignition gas engines. The general design of the units, known as model 38F5¼, is characterized by a pair of pistons in each cylinder, operating in opposite directions, and with a common combustion space formed by the heads of the pistons.

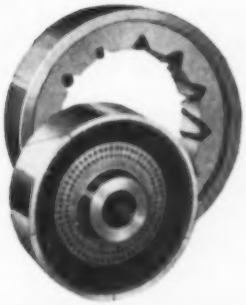
The engine is available as a self-contained unit, having an attached rotary-type blower for supplying scavenging air and all required pumps and auxiliaries.



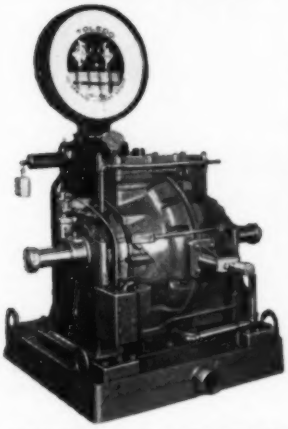


AIR COOLED COUPLINGS

AJUSTO-SPEDE MOTORS



AIR COOLED BRAKES



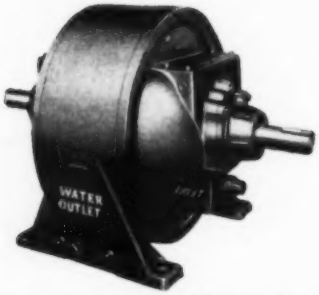
ABSORPTION DYNAMOMETERS

EATON

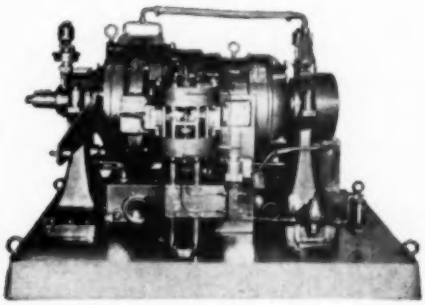
DYNAMATIC

EDDY-CURRENT ROTATING EQUIPMENT

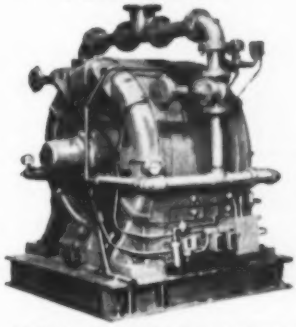
PRESS DRIVES



LIQUID COOLED COUPLINGS



UNIVERSAL DYNAMOMETERS



LIQUID COOLED BRAKES

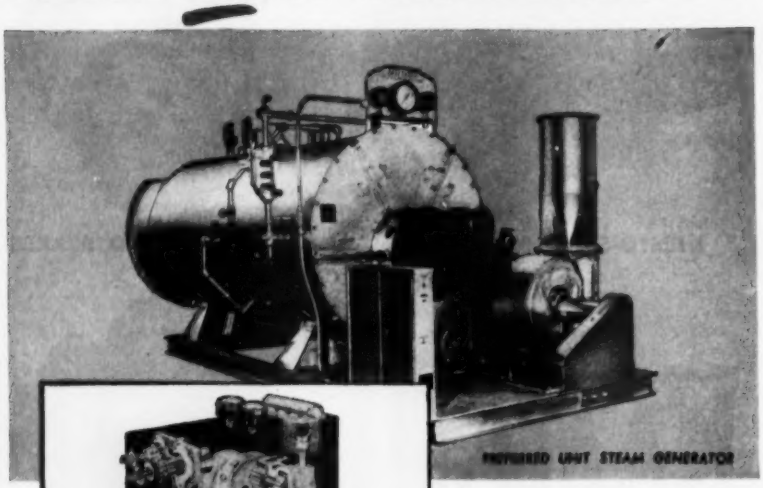
Dynamatic Eddy-Current electro-magnetic equipment represents the ideal solution for a wide range of adjustable-speed drive problems, particularly where an AC power source is a requirement. Typical applications include paper machine drives, cement mill drives, industrial truck clutches, press drives, crane brakes, fan drives—in fact, practically all test, processing, and conveying equipment common to industry. Instantaneous response and accurate control are important advantages.

Write for your copy of Bulletin GB-1 which describes and illustrates the basic Dynamatic units.

DYNAMATIC CORPORATION KENOSHA • WISCONSIN

Subsidiary of EATON MANUFACTURING COMPANY, Cleveland, Ohio

there *IS* a difference*



*Voluvalve Fuel Regulator... another 25 year built in Preferred "Quality Feature" that means accurate, *efficient* combustion.

when you're burning BUNKER "C"

Preferred's Unit Steam Generator handles any and *all* the variations of Bunker "C" and No. 6 oil that are coming through these days from catalytic cracking . . . and they do it *better* and *more efficiently* than any other unit steam generator on the market because—

**No other unit has Preferred's "Voluvalve"* Fuel Regulator! In conjunction with a constant displacement pump the "Voluvalve" — through *positive*, reciprocal proportionate gearing—supplies an exact and accurately metered amount of oil to atomizer or fuel feed system.

**No other unit has Preferred's High-Speed Atomization* —taking the metered fuel, Preferred's rotary cup speeds at *4600 RPM* and easily atomizes the most viscous oil to a fine spray. Higher air velocities provide for greater collision effect and better atomization and allow complete control of spray angulation for carbon-free operation.

Write or call for complete details of "quality features" described in Bulletin 2000.

PREFERRED UTILITIES MFG. CORP.
1860 BROADWAY • NEW YORK 23, N.Y. 202

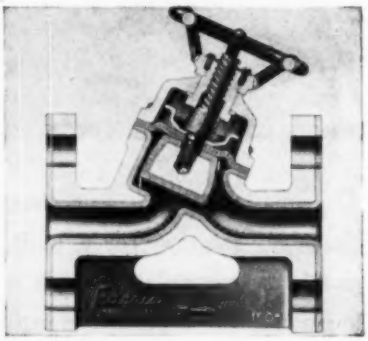
new equipment

(Continued from page 28)

an endless belt type furnace. A series of synchronized vertical-moving pushers, cut on a 30 deg angle, remove parts from the hopper, raising them to the next level and causing them to roll off by gravity. The material continues to be elevated and transferred through a series of cycles until discharged into the furnace.

TO REQUEST ADDITIONAL DATA

Insert "key" numbers on return post card found on page 99. Your requests will be handled promptly.



Valve for corrosive and abrasive service

E40 Farris Flexible Valve Corp. announces design improvements in X-V Series diaphragm valves, designed primarily for acids, chemicals, and other corrosive and abrasive fluids. The principal design feature is the individual functioning of the diaphragm and the disc. As a result, the diaphragm is not subjected to seat wear and abrasion. In addition, this design makes

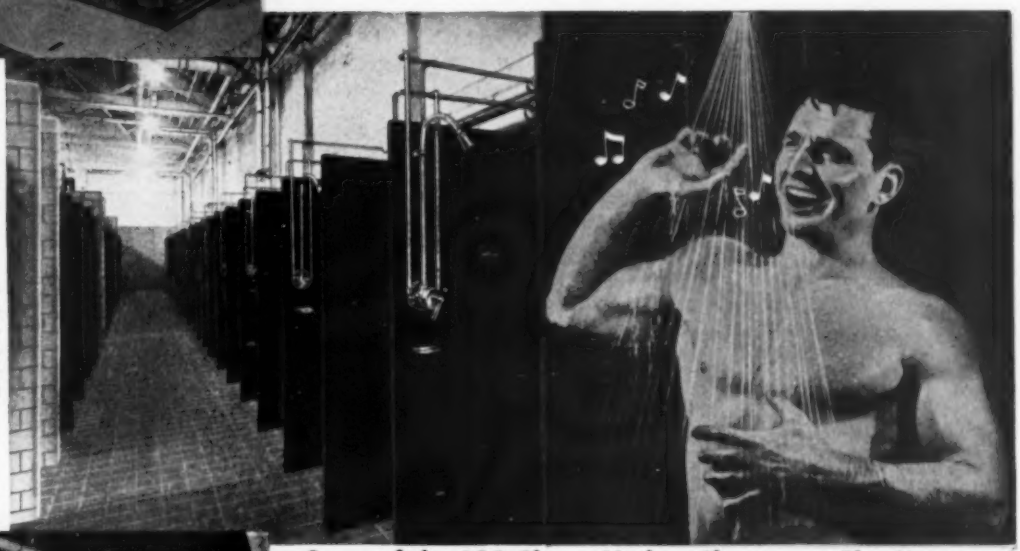
(Continued on page 34)

Workers Sing in the Showers
Regulated by POWERS
at The SINGER MANUFACTURING CO.
Plant in Elizabethport, New Jersey

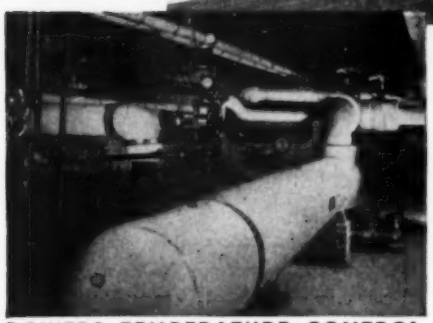
Above:
A magnificient new model in the already world-famous line of SINGER Sewing Machines

•

Right:
One of Singer's Shower rooms has 98 showers, another 58 and there are several smaller ones for individual groups.



Some of the 190 Clean, Modern Showers at The Singer Mfg. Co. Each shower is individually controlled by a



POWERS TEMPERATURE CONTROL on HOT WATER GENERATORS

serving the various shower rooms is shown above. For this type of service a Powers ACCRITEM Regulator and FLOWRITE Valve are often used.

When You Have Problems of Water Temperature Control contact Powers nearest office. With over 60 years experience and a most complete line of controls we are well qualified to help you.

Mixer for Exposed Piping

POWERS

Thermostatic WATER MIXER

The Best Showers that money can buy — is only one of the many reasons why employees remain almost twice as long with SINGER as the national average.

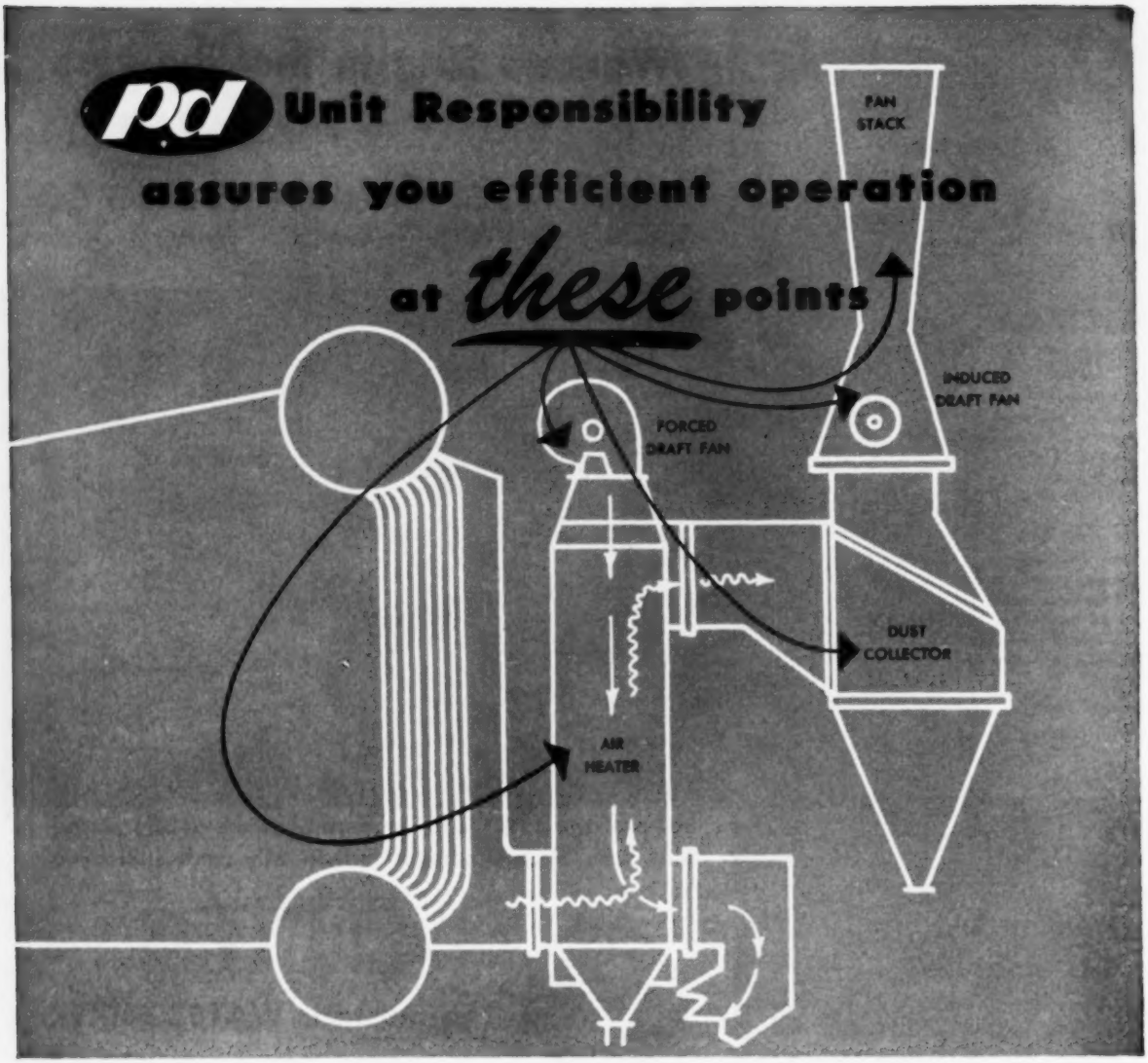
Mr. F. H. Gummick, Plant Engineer for this famous 100 year old firm, says "The Singer Mfg. Co. has provided employees with the best shower room equipment obtainable. We consider it an investment in good employee relations."

Powers Temperature regulators on each individual shower as well as on the hot water generators serving the showers is the best insurance for a SAFE, COMFORTABLE shower.

No Unexpected "Shots" of icy cold or scalding water here. Powers *thermostatic* water mixers always keep the water temperature just right — regardless of **pressure** or **temperature** changes in water supply lines. Write for catalog Rb24.

(b14) • ***Only ONE Shower Accident Can Cost Many Times More Than POWERS Water Mixers*** •

Established in 1891 • THE POWERS REGULATOR COMPANY • SKOKIE, ILL. • Offices in Over 50 Cities



Unit Responsibility, for important components of plant design by the Prat-Daniel Corporation, relieves your engineers of necessary problems of coordination that often arise when equipment is purchased from several sources.

Prat-Daniel, designing and manufacturing engineers of *Forced Draft Fans*, *Air Preheaters*, *Tubular Dust Collectors*, *Induced Draft Fans* and *Fan Stacks*, make possible this coordination of components by a single company with over a quarter of a century experience in the power field.

This service is offered through The Thermix Corporation, project engineers for Prat-Daniel. Specialists in this field, they can assure you a completely integrated system. Why not contact Thermix today. Ask for the new P-D Bulletin 4P201.

Project Engineers for Power Plant Division

THE THERMIX CORPORATION

GREENWICH, CONN.

(Offices in 38 Principal Cities)

Canadian Affiliates: T. C. CHOWN, LTD., Montreal 25, Quebec; Toronto 5, Ontario

Designers and Manufacturers

PRAT-DANIEL CORPORATION

SOUTH NORWALK, CONN.

POWER DIVISION: Tubular Dust Collectors, Forced Draft Fans, Air Preheaters, Induced Draft Fans, Fan Stacks.

ABOVE: Vital to the high production maintained by Gunnison Homes, Inc. is this 650-ton hydraulic press used to bond plywood panels into strong, durable wall sections.
LEFT: Handsome, precision built homes, like the Gunnison Coronado pictured here, are built in a matter of hours.

Answers a pressing need for Gunnison Homes, Inc. . . .

● Gunnison Homes, Inc., situated in New Albany, Indiana, is one of the leaders in the field of manufactured homes. Key to continuous production of precision built homes at the New Albany plant is the 650-ton hydraulic press, shown above, which was installed in 1947. This press processes ten plywood panels every cycle by the combination of heat and pressure . . . a tough job and one requiring reliable hydraulic performance to maintain production schedules.

STANOIL Industrial Oil was installed in the press when it was put into operation six years ago. STANOIL has stood the test of severe operation . . . with no evidence of oil deterioration being found during a recent inspection of the hydraulic system. Operation has been efficient. Minimum make-up oil has been needed to maintain the oil capacity of 450 gallons.

STANOIL
TRADE MARK
Industrial Oil

Find how STANOIL can benefit you by discussing this multi-purpose oil with a Standard lubrication specialist. You can contact him by phoning your local Standard Oil office. Or, write: Standard Oil Company, 910 S. Michigan Ave., Chicago 80, Ill.

What's YOUR problem?

Ralph E. Murnahan, of Standard Oil's Evansville office, is the lubrication specialist who keeps in constant contact with Gunnison Homes to make certain that there is no interruption of operation due to lubrication difficulties.

He is one of many lubrication specialists who make their headquarters in Standard's offices throughout the Midwest. These men have been specially trained in Standard's Lubrication Engineering Schools and, in addition, have a wealth of on-the-job experience.

To obtain the service of the lubrication specialist in your area, you need only call your local Standard Oil office. The lubrication specialist will discuss your lubrication problems with you . . . at no obligation to you, of course. He has a complete line of petroleum products to offer you, including:

SUPERLA Greases—Available in a wide range of consistency grades and in both lime-soap and soda-soap types. SUPERLA Greases cover a wide range of operations. These efficient products are comparable in quality with the highest type of special greases.

STANOLITH Greases—Because these unique lithium soap products possess the heat resistant properties of soda-soap greases and the water resistant properties of lime-soap greases, they offer a solution to lubrication problems caused by the presence of both heat and water.

STANDARD OIL COMPANY

STANDARD *(Indiana)*

2 Accelators®

DO A **BIG JOB** IN A **SMALL SPACE!**

in a South American **DISTILLERY**

Two 44′ diameter Accelators treat 2800 gpm of Parana River water for clarification and color removal at a San Nicolas distillery in Buenos Aires. A portion of the treated water is used for boiler feed with supplementary treatment.

Elevated to provide gravity flow of clarified water to filters located over a clearwell, these Accelators provide water supply in a fraction of the space required by other types of water treating equipment.

Learn how the Accelator can solve your water treatment problem in *less* space at *lower* cost. Send for informative, illustrated bulletin (see coupon below).

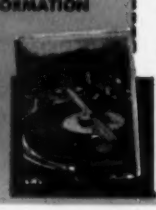
INFILCO

INFILCO INC. | *Tucson, Arizona*

Plants in Chicago & Joliet, Illinois

FIELD OFFICES IN 26 PRINCIPAL CITIES

USEFUL INFORMATION FOR YOU →



INFILCO INC., Box 5033, Tucson, Arizona

Please send us your Accelator Bulletin 1825-Y

NAME_____

TITLE_____

COMPANY_____

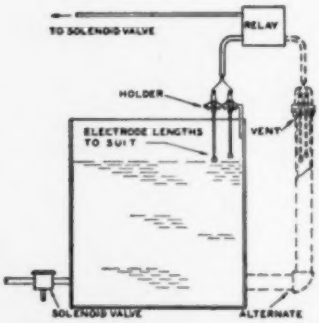
STREET_____

CITY_____ ZONE____ STATE_____

new equipment

(Continued from page 30)

it possible to close the valve in event of a diaphragm failure. Other features include a replaceable disc, full port capacity, easy-to-read valve position indicator, and low pressure drop. Sizes range from ½ through 4 in.

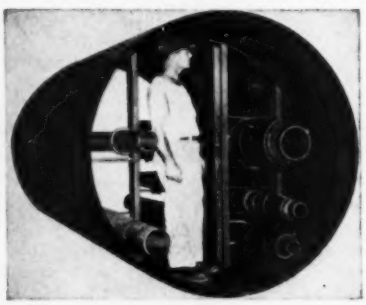


Liquid level control is simplified

E41 Three time-tested, standardized components are incorporated in a liquid level control system designed by Johnson Corp. These consist of a Johnson electrode holder, a relay, and a Johnson direct operated solenoid valve. In operation, a circuit between two stationary electrodes is established or broken by rising or falling of the liquid level. The circuit actuates a relay, which in turn operates a solenoid valve. Sizes are available to meet a wide range of requirements.

TO REQUEST ADDITIONAL DATA

Insert "key" numbers on return post card found on page 99. Your requests will be handled promptly.



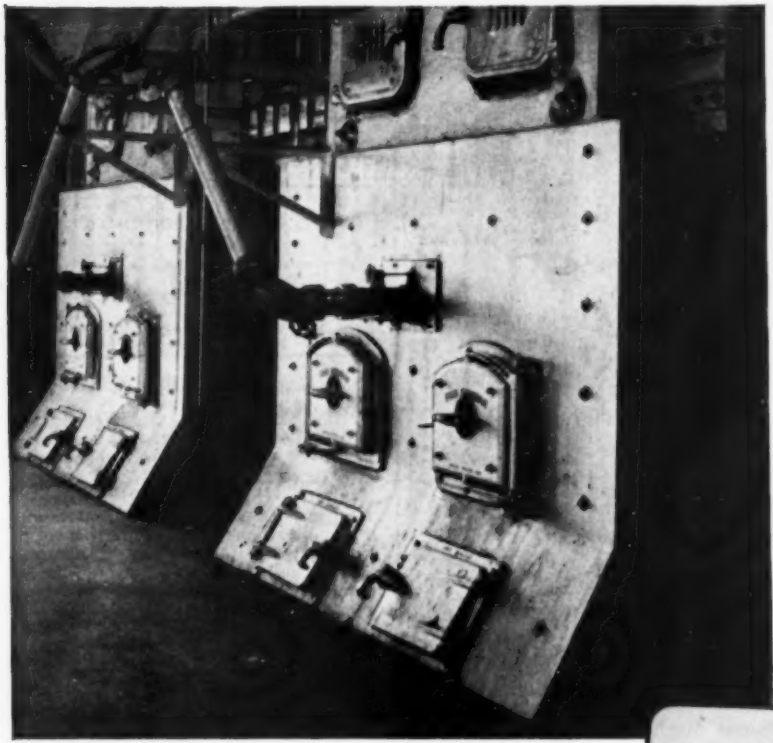
Prefabricated tunnel system protects utility services

E42 To protect underground distribution piping and other utility services, The Ric-wiL Co. has devel-

(Continued on page 36)

HOW A SMALL PLANT SAVES BIG MONEY— BY BURNING COAL THE MODERN WAY!

"Modernizing our coal installation cut monthly fuel bills from $777 to $650... labor costs from $120 to only $40!"



says Mr. William C. Musch, Chief Engineer, Allen Memorial Hospital, Waterloo, Iowa.

Here's Allen Memorial Hospital's new steam plant. Boilers are fired by pneumatic spreader stokers. The plant now operates with ⅓ the manpower formerly needed. Compared to the old installation, the new equipment saves 18¢ on every thousand pounds of steam generated. The savings realized by this small plant will pay for the entire installation in 7½ years.

● Whether you plan to modernize your steam plant, or build a new one...whether you burn a lot of fuel, or a little...you can cut a *big* percentage from your operating costs by using up-to-date coal equipment.

A consulting engineer can show you how you can cut labor costs to a minimum with automatic coal- and ash-handling equipment...how you can get more steam for every dollar when you burn coal in a modern installation designed to meet your *specific* needs.

Of all fuels, only coal has ample reserves for the future. And to produce this coal, America has the world's most efficient coal industry. That means that coal users, unlike those committed to other fuels, get the advantages of dependable supply and relatively more stable prices—now and for the future!

If you operate a steam plant, you can't afford to ignore these facts!

COAL in most places is today's lowest cost fuel.

COAL resources in America are adequate for all needs—*for hundreds of years to come.*

COAL production in the U. S. A. is highly mechanized and by far the most efficient in the world.

COAL prices will therefore remain the most stable of all fuels.

COAL is the safest fuel to store and use.

COAL is the fuel that industry counts on more and more—for with modern combustion and handling equipment, the inherent advantages of well-prepared coal net even bigger savings.

BITUMINOUS COAL INSTITUTE

A Department of National Coal Association, Washington, D. C.

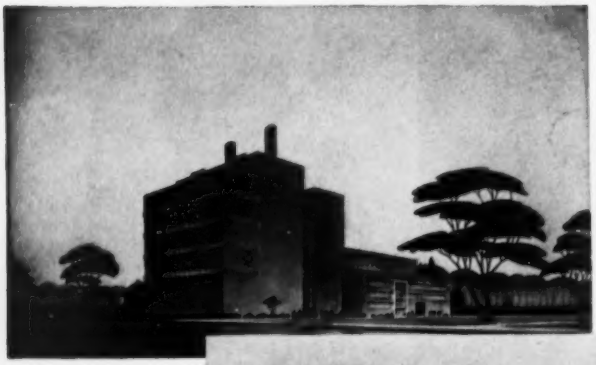
FOR HIGH EFFICIENCY & FOR LOW COST

YOU CAN COUNT ON COAL!

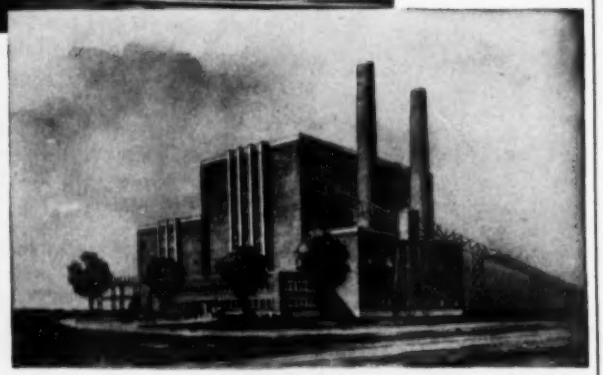
ON THESE TWO INSTALLATIONS

the AEROTEC SERIES

Assures 97.5% FLY ASH COLLECTION Efficiency



LEFT: The 264,000 kw (four units) J. Clark Keith Generating Station of The Hydro-Electric Power Commission of Ontario at Windsor, Canada. H. G. Acres & Co., Niagara Falls, Ontario, Consulting Engineers.



RIGHT: The 400,000 kw (four units) Richard L. Hearn Generating Station of The Hydro-Electric Power Commission of Ontario at Toronto, Canada. Stone & Webster Engineering Corp., Boston, Mass., Engineers and Constructors.

Here's on-the-job proof that Aerotec Series Mechanical-Electrical Dust Collectors are used for continuous efficiency. Guaranteed 97.5%, at normal full load the overall efficiency is anticipated as high as 99% at these two Canadian generating stations of The Hydro-Electric Power Commission of Ontario. Aerotec Series Collectors serving each plant combine a design 3RAS Mechanical and an Electrical Precipitator.

In the Mechanical unit, small diameter, permanent molded aluminum tubes provide high efficiency. Exclusive Aerotec pocket type collecting electrodes in the Electrical Precipitator reduce reentrainment of dust in the gas stream, contributing to a sharp improvement in stack appearance. The combined actions of these units assure maximum dust collection efficiency. Many Aerotec Series installations verify that fact.

Your plant can eliminate dust nuisances with Aerotec equipment just as many well-known companies have done. This highly successful performance is a reliable measure of Aerotec ability to solve your dust collection problems. Write our Project Engineers today!

Project Engineers

THE THERMIX CORPORATION

GREENWICH, CONNECTICUT

(*Offices in 38 Principal Cities*)

Canadian Affiliates: T. C. CHOWN, LTD.

Montreal 25, Quebec Toronto 5, Ontario

THE AEROTEC CORPORATION

GREENWICH, CONN.

new equipment

(Continued from page 34)

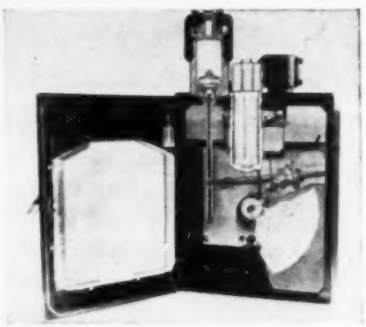
oped a large diameter conduit system known as Utilidor. It is completely prefabricated to job requirements, with distribution piping for steam, condensate, water lines, fire lines, or process purposes all in place and insulated where required. Traps, valves, and expansion devices are included, as well as provisions for electrical and communication cables, ceiling lights, and pedestrian passageway or conveyor systems. Units are shipped in approximately 21 ft lengths with simple joint connections.

TO REQUEST ADDITIONAL DATA

Insert "key" numbers on return post card found on page 99. Your requests will be handled promptly.

Hose resists heat

E43 To eliminate twisting and knotting which occurs when separate lines are used with gas welding apparatus, Hewitt-Robins Inc. has developed an improved hose consisting of double tubes vulcanized to form a single line. Other important features include resistance to heat and flame, light weight, and resistance to abrasion and oil.



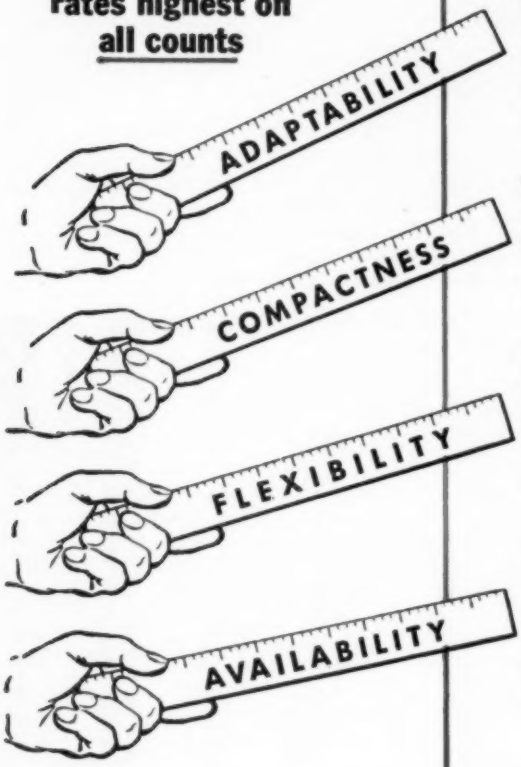
Mercury manometer eliminates pressure-tight bearing

E44 By incorporating a magnetic coupling between the float and follow-up linkage of a high pressure mercury manometer, Fisher & Porter Co. reports the elimination of problems resulting from pressure-tight bearings, lubricants, and fluid leakage. The unit is designed for routine operation at pressures to 5000 psi. Stainless steel float and range tubes are employed to permit use with corrosive fluids. Applications include high pressure steam installations, petroleum and natural gas production, and high pressure chemical and petroleum process reactions.

—End

Four ways to measure REAL PUMPING ECONOMY

You'll find that the I-R MOTORPUMP rates highest on all counts



The Motorpump line is so complete that you can get a pump that's designed to handle your particular capacity and head requirements at *maximum efficiency*. Sizes range from ¼ to 50 hp, for capacities from 5 to 1800 gpm and heads to 650 ft.

The space-saving design and light weight of the unit-type Motorpump cut installation costs. Motorpumps can be mounted in "close quarters" where no other type of pump would fit. No special foundations are required.

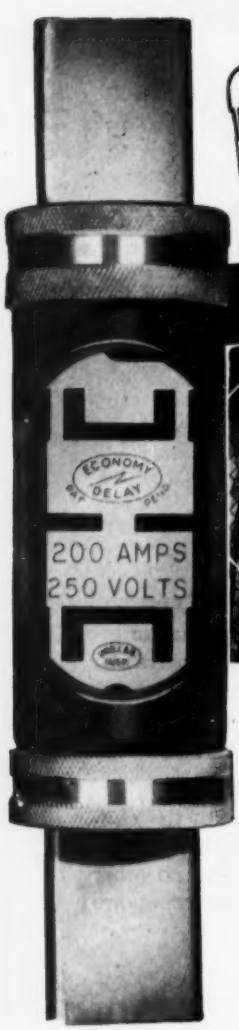
Motorpumps operate equally well in *any position*—can be mounted horizontally, vertically, or any angle; on floor, wall, columns or ceiling. This flexibility of mounting often permits simpler and more economical piping arrangements.

Despite current shortages of many industrial products, you can still get prompt delivery on Ingersoll-Rand Motorpumps. Most of the popular sizes are carried in stock and can be delivered immediately from branch or factory. This avoids costly delays—both in pump replacement and new installations.

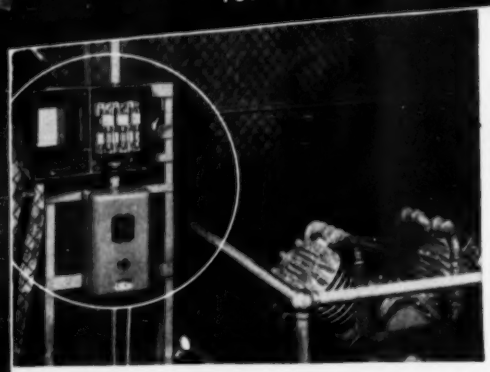
MOTORPUMP **Ingersoll-Rand**

11 BROADWAY, NEW YORK 4, N. Y. 758-9

ROCK DRILLS • COMPRESSORS • AIR TOOLS • CENTRIFUGAL PUMPS • TURBO BLOWERS • CONDENSERS • DIESEL AND GAS ENGINES



for FUSE ECONOMY . . . use ECONOMY FUSES



Extra Protection for "OFF and ON" Circuits

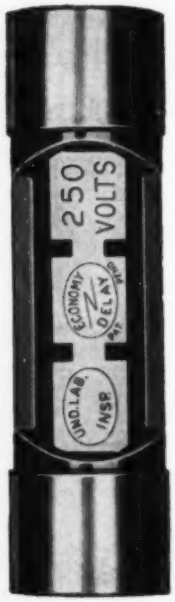
On this air compressor circuit—a typical example of high starting torque—the motor goes on-and-off approximately 120 times in the course of a 10-hour day.

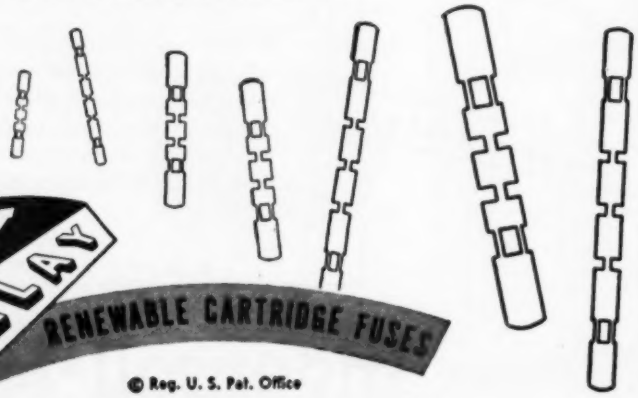
The "ECONOMY DELAY" Fuses shown in this application, operating under these extreme conditions, have blown rarely. If a fuse does blow, all that is required to restore the original fuse efficiency is to insert a new "ECONOMY DELAY" Renewal Link. This requires only a minute or two—which means minimum "down time"... and the cost of an "ECONOMY DELAY" Renewal Link is 3 cents per blow!

The life of an Economy Fuse Cartridge is practically infinite, so, you save money on fuse maintenance and at the same time conserve scarce brass and copper.

Give the extra protection of "ECONOMY DELAY" Fuses to all your circuits. Your wholesaler has "ECONOMY DELAY" Renewable Fuses and Renewal Links in stock.

Ask for the ECONOMY Catalog and Price List.



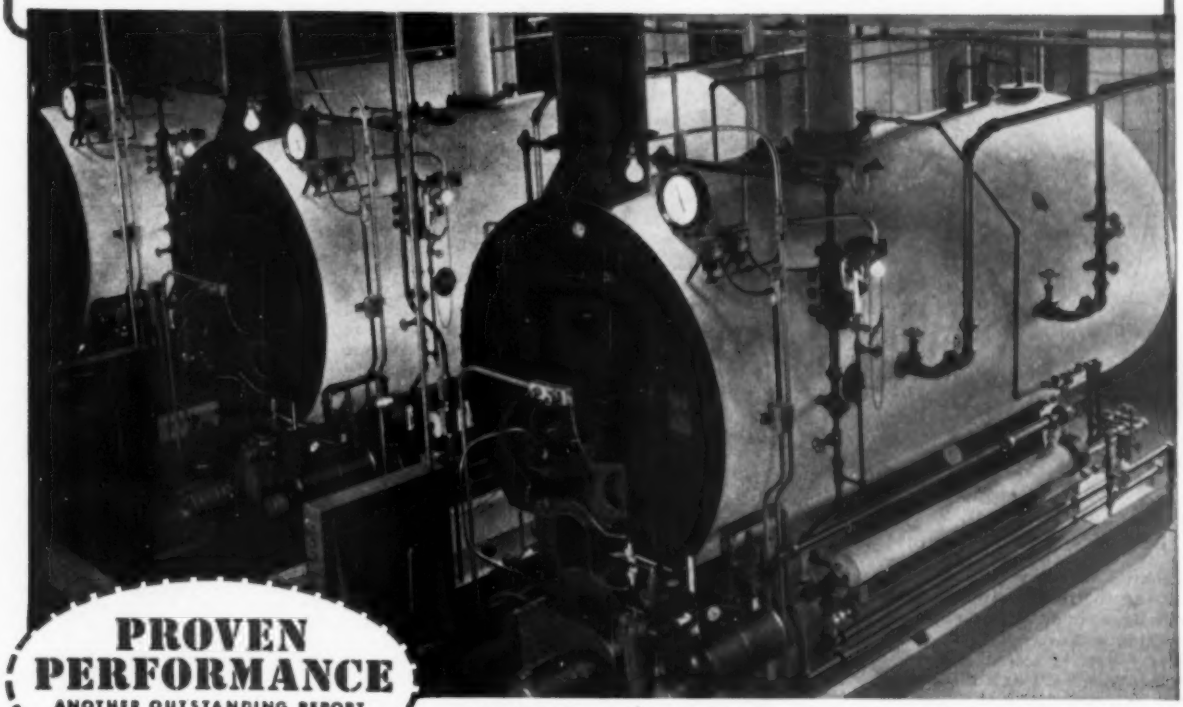


ECONOMY DELAY RENEWABLE CARTRIDGE FUSES

© Reg. U. S. Pat. Office

ECONOMY FUSE AND MFG. CO., 2717 GREENVIEW AVE., CHICAGO 14, ILLINOIS REPRESENTATIVES IN ALL PRINCIPAL CITIES

Cleaver-Brooks boilers save $25,000 per year for Hoosac Mills...pay for themselves in 2 years' time!



PROVEN PERFORMANCE
ANOTHER OUTSTANDING REPORT FROM A CLEAVER-BROOKS OWNER

After installation and starting service was completed, a check was made on boiler output. Tests indicated efficiency exceeded the guaranteed 80%. After eight months' operation without tube cleaning, stack temperature showed no noticeable gain, indicating high efficiency had been maintained. *Planned and installed by Frank I. Rounds Co., Newton Highland, Mass.*

INSTALLING 3 Cleaver-Brooks self-contained boilers at Hoosac Textile Mills, New Bedford Division, was a major step in ending boiler worries. Hoosac can count on yearly savings of $25,000, and they're set up for future expansion as well.

Before deciding what type of boilers to install for replacing old, hand-fired boilers, Hoosac carefully considered these factors:

1. **Efficiency of steam generation** — the cost for supplying 12,000 lbs. of steam required each hour at peak capacity for heating and processing.
2. **Saving labor costs** — through safe, automatic operation.
3. **Cleanliness** — important to textile manufacture.

A study of past performance and prominence of similar units in the industry — showed that Cleaver-Brooks self-contained boilers would fill the bill.

Guaranteed 80% thermal efficiency was one of many influencing factors in selecting the 3 Cleaver-Brooks 150 hp. boilers. Even with loads as low as 30% of rating, these boilers operate with a flat 80% efficiency. (Hoosac operates their plant over widely fluctuating loads, particularly in summer.)

That they attained their objectives is borne out by these results — *results which showed the boilers paid for themselves in 2 years' time.*

1. **$15,000 savings in fuel** — fuel cost studies showed 275,000 gals. of oil at 5½¢ per gal. provide steam for a year's operation. Same steam formerly required 2,000 long tons of coal at $15.00 per ton.
2. **$10,000 savings in labor costs** — fully automatic operation minimized boiler maintenance. Personnel were then available for productive plant work.
3. **Cleanliness** — modern boiler room proved more efficient than previous cluttered arrangement. Hand firing, removal and disposal of fly-ash was eliminated.

In addition to these substantial savings, the installation provided for economical future plant expansion. At present, boiler operation is rotated so all three periodically receive the same service and maintenance.

Cleaver-Brooks boilers are showing similar savings in many other businesses. Investigate — write for Catalog AD-100 and complete information on standard size oil, gas, combination oil/gas fired Cleaver-Brooks boilers, 15 to 500 hp., 15 to 250 psi.

CLEAVER-BROOKS COMPANY
Dept. F, 303 E. Keefe Ave.,
Milwaukee 12, Wis., U.S.A.

Cleaver-Brooks
ORIGINATORS OF THE SELF-CONTAINED BOILER
Steam Boilers • Oil and Bitumin Tank Car Heaters • Distillation Equipment
Oil and Gas Fired Conversion Burners

How to make packings last longer

Tips by Johns-Manville Engineers to help you keep production rolling

Keep equipment in repair for best packing service

Worn shafts wear me down

Trying to make packing compensate for excessive shaft or rod wear will shorten packing life materially without alleviating the undesirable condition. Pack correctly to avoid excessive shaft and rod wear. Replace worn shafts and rods as soon as possible to avoid adding the expense of damaged packings to the cost of parts replacement.

"Bucking" shafts throw me!

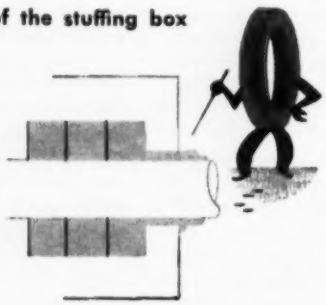
Packings are for sealing only. Trying to compensate for shaft misalignment or vibration by overpacking and excessive gland pressure results in scored shafts and ruined packing. Think of a stuffing box as a potential brake assembly that may develop considerable frictional resistance with attendant heat and wear.

Keep my lantern clear

If the stuffing box is equipped with an oil, grease or water lantern, its purpose is defeated when the lantern ring is omitted or the opening blocked by improperly installed packing or other obstruction. This can deprive the packing of lubrication or cooling and result in premature failure.

Don't let me get out of the stuffing box

If the shaft or rod is badly worn, the packing may be extruded into the system when the gland follower is taken up. Considerable difficulty such as packing getting into valves or traps or contaminating the fluid handled may result. Rebush the stuffing box or use a junk ring to reduce the clearance.



Why you can expect maximum service from

CENTRIPAC ROD PACKING Style No. 7

Made from long fibre asbestos yarn, plaited (not pressed) square, thoroughly lubricated and graphited, J-M Centripac has been, for many years, a preferred high-quality packing for centrifugal pumps and other equipment with rotating or oscillating rods. You can count on it to stand up against water — fresh, salt, hot or cold — oil, ammonia, brine, gasoline and some weak acids and chemicals.

Your distributor will help too! Your J-M Packing Distributor can help you take the guesswork out of packing problems. He carries complete stocks of Johns-Manville quality packings and can supply you promptly. For the address of the J-M Packing Distributor nearest you, write Johns-Manville, Box 60, New York 16, N.Y.

JOHNS-MANVILLE JM PRODUCTS

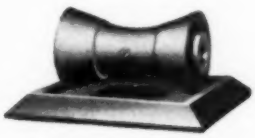
Johns-Manville PACKINGS & GASKETS

ADJUSTABLE PIPE HANGERS AND SUPPORTS

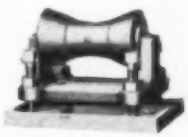
for every piping requirement

NO. 3 OF A SERIES SHOWING THE GRINNELL LINE

pipe rolls

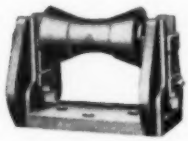


Pipe Roll and Plate
Fig. 277
2 to 30 in. pipe

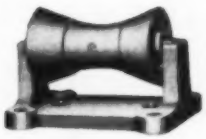


Adj. Pipe Roll with Base
Fig. 274
Without base: Fig. 275
2 to 30 in. pipe

Adj. Swivel Pipe Roll
Fig. 174
2½ to 12 in. pipe



Adj. Pipe Roll
Fig. 276
4 to 30 in. pipe



Pipe Roll Complete
Fig. 271
2 to 30 in. pipe

Single Pipe Roll
Fig. 171
1 to 30 in. pipe

pipe saddles

Pipe Stanchion Saddle
Fig. 259
4 to 36 in. pipe

Adj. Pipe Saddle Support
Fig. 264
2½ to 36 in. pipe

Pipe Saddle Support
Fig. 258
4 to 36 in. pipe

Anchor Chair
Fig. 197
4 to 24 in. pipe

Pipe Covering Protection Saddle
Figs. 185, 186, 187, 188
Type A for 10 in. and smaller

Pipe Covering Protection Saddle
Figs. 185, 186, 187, 188
Type B for 12 in. and larger

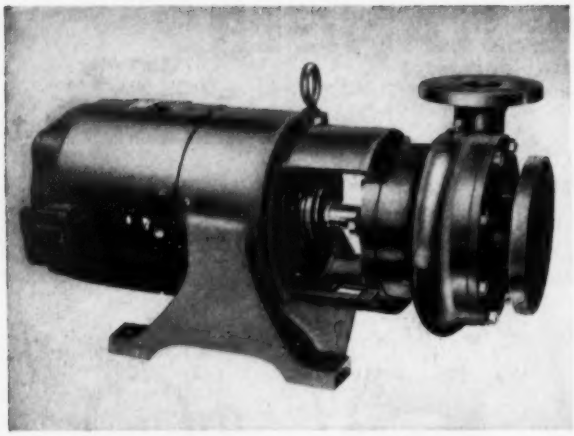
Write for Hanger Catalog

GRINNELL

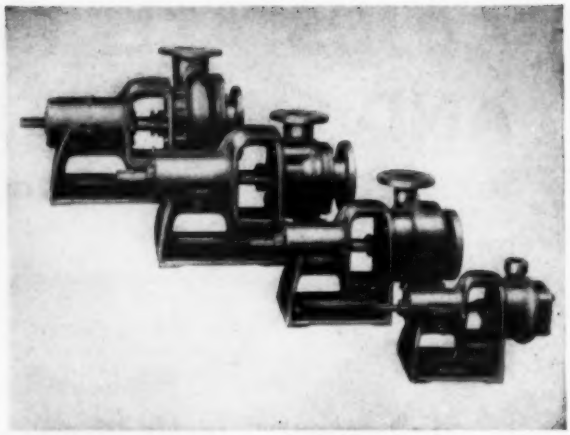
WHENEVER PIPING IS INVOLVED

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

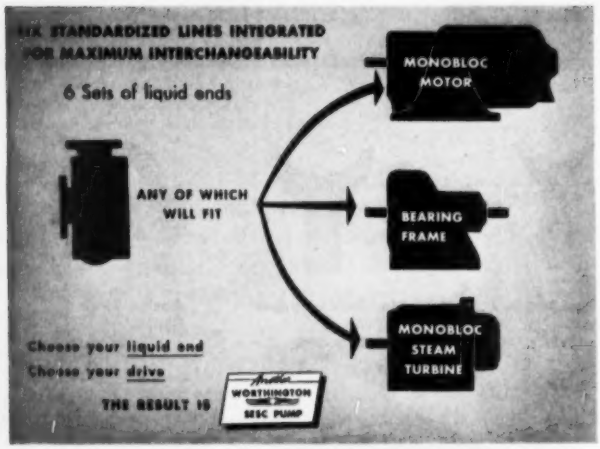


WITH BUILT-IN MOTOR—Well known throughout industry is this compact streamlined Worthington Monobloc centrifugal pump. Worthington SESC standardization makes it possible to interchange any of six sets of liquid ends to the motor housing.



FOR ANY CONVENIENT DRIVE—Frame-mounted units are available in four frame sizes. Like the Monoblocs, they use the same six sets of liquid ends and either conventional packing or a standardized mechanical seal that is readily changed in the field if necessary.

Why Worthington's SESC* pump line means greater availability, broader selection, easier servicing



STANDARDIZATION of *parts*, *mountings*, *materials* and *dimensions* virtually eliminates the necessity of slow and expensive custom manufacture to meet special pumping requirements. From 650 parts within its six standardized sets of liquid ends, Worthington can assemble 60,000 *different* standard pumps! C.3.1

Greater availability because the new Worthington pump line will handle more requirements with a *standard*, readily obtainable unit.

Broader selection because of the complete range of ratings and special design features in the 60,000 different SESC pumps.

Easier servicing because standardized parts mean lower parts-inventory requirements.

This sums up the advantages you can expect when you use Worthington standardized centrifugal pumps. The SESC line is Worthington's latest move towards assuring you the *right* pump for the job.

For more information, contact your local Worthington distributor or write for Bulletin W300 B-4 to Worthington Corporation, Centrifugal Pump Division, Harrison, New Jersey.

*Standardized End Suction Centrifugal

The World's Broadest Line Assures You The Right Pump For Every Job

WORTHINGTON
Centrifugal Pumps

the practical answer to your rust problems indoors and out . . . . . so easy to use that one man often does the work of two.

RUST-OLEUM®

STOPS RUST!

Resists Rain, Snow, Heat, Fumes, Weathering, Salt Water, etc.

Rust-Oleum *cuts costly manhours!* Just scrape and wirebrush to remove rust scale and loose rust . . . then brush Rust-Oleum 769 Damp-Proof Red Primer *directly over the sound rusted surface.* Rust-Oleum finish coatings available in many colors, aluminum, and white give you *double protection.* Sandblasting and other costly preparations are *not* usually required. Specify Rust-Oleum . . . prompt delivery from Industrial Distributor stocks in principal cities.

RUST-OLEUM CORPORATION
2473 Oakton Street, Evanston, Illinois

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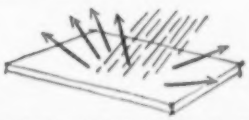
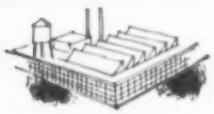


Practical, Economical Answer To Your Rust Problem—Rust-Oleum resists rain, heat, fumes, sun, salt air, salt spray, and many chemicals—as well as condensation indoors.



Proved Throughout Industry For Over 25 Years—On tanks, girders, pipes, machinery, roofs, buildings, fences, stacks, throughout industry — Rust-Oleum has proved its capacity to stop rust for over 25 years.

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Distinctive as your fingerprint, Rust-Oleum is an *exclusive formula* developed by a Master Mariner during more than 20 years battling actual rust conditions at sea. It incorporates a *specially-processed* fish oil vehicle that will *dry,* is odor-free, and is formulated in *many colors.* Be sure you specify genuine Rust-Oleum to assure satisfaction. Accept no substitute.

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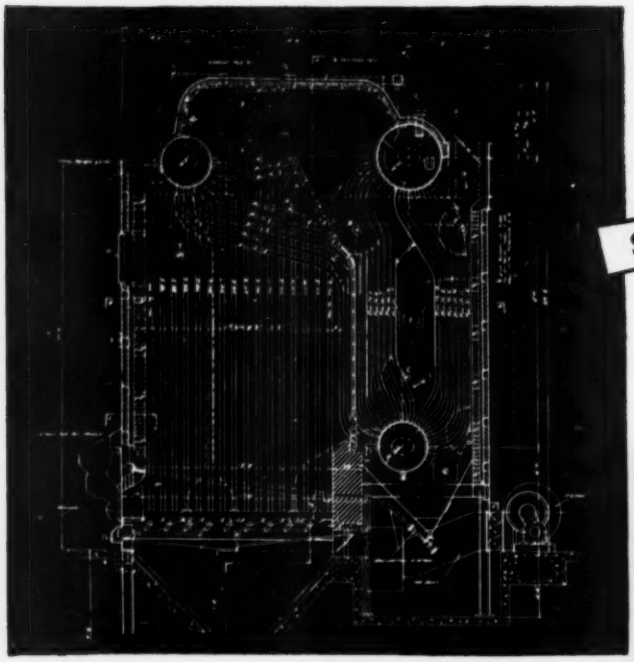
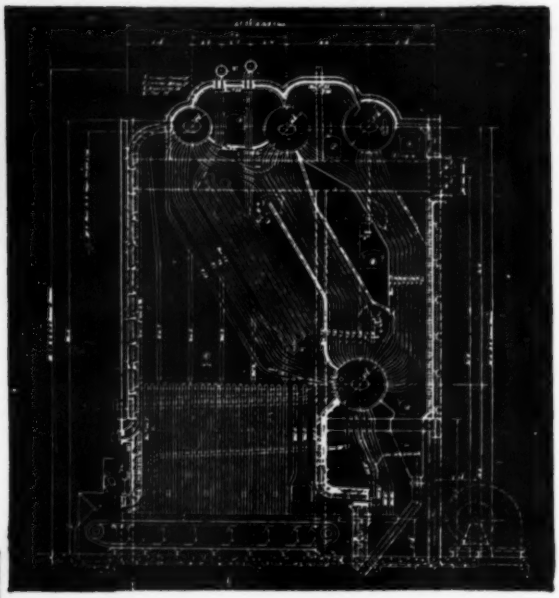


Carry high overloads with high efficiency

SPECIFY Vogt

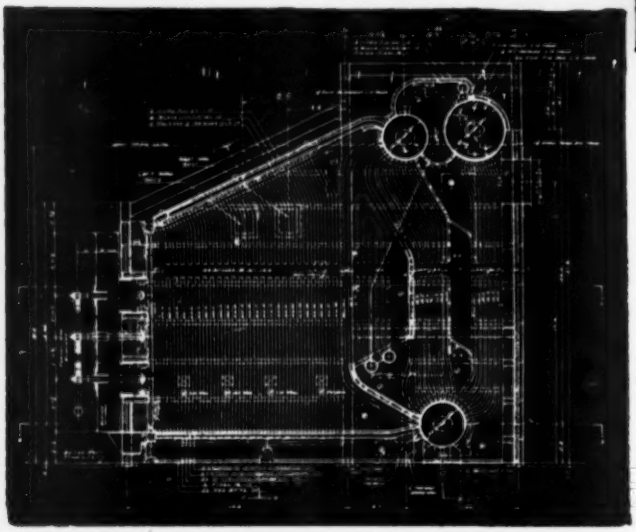
STEAM GENERATING UNITS



CLASS VL Two 27,500 pounds per hour units, installed at Brown-Forman Distillers Corporation, Louisville, Ky. Features large furnace volume in limited space, with high ratio of radiant heating surface.

CLASS LE Mt. Carmel Public Utility, Mt. Carmel, Illinois, is served by this 60,000 pounds per hour unit. Generous steam liberating surfaces and steam space permit wide fluctuations in load.

CLASS VR 70,000 pounds per hour steam generator at Humble Oil and Refining Company, Johnsue, Texas. An efficient, high-duty unit with water cooled furnace, using refinery gas fuel.



Vogt builds a complete line of bent tube steam generators, designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Superheaters, air preheaters, economizers, water walls and soot blowers can be readily incorporated. Bulletins with general information and showing typical installations are available upon request.

HENRY VOGT MACHINE CO.
LOUISVILLE 10, KENTUCKY

BRANCH OFFICES:
NEW YORK, PHILADELPHIA, CLEVELAND
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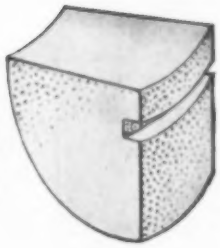
B&W KAOCAST goes in more furnaces because...

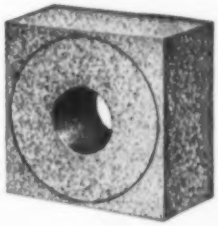
Versatile B&W Kaocast can be molded quickly and easily with your own labor. It can also be cast directly in place or applied with a cement gun. This unique 3000 degree refractory castable has high resistance to spalling and slag attack, low volume change and negligible reheat shrinkage. Consult a B&W Refractories Engineer on your specific applications and see how B&W Kaocast can save money for you.

It cuts inventory



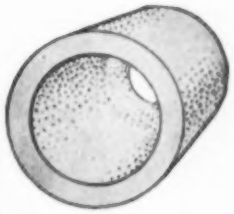
Nose arches for oil heaters were formerly made with special shapes of ordinary firebrick. Switching to quickly moldable Kaocast eliminated need for expensive special-shape inventory . . . minimized delays. In addition, side by side tests proved that Kaocast far outlasted the ordinary firebrick.

It speeds repairs



Kaocast was specified for the charging front of a forging furnace, used to heat heavy pipe ends. The reason? Kaocast linings were molded faster . . . give longer service, could be made when convenient and stored 'til needed.

It lasts longer



A chemical plant found that burner tile for a heating furnace made of an ordinary castable stood up only 3 to 4 months. But Kaocast burner tile stayed on the job 16 months and longer. Thousands of pounds of Kaocast have been used for this and many other applications in this plant.

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R469

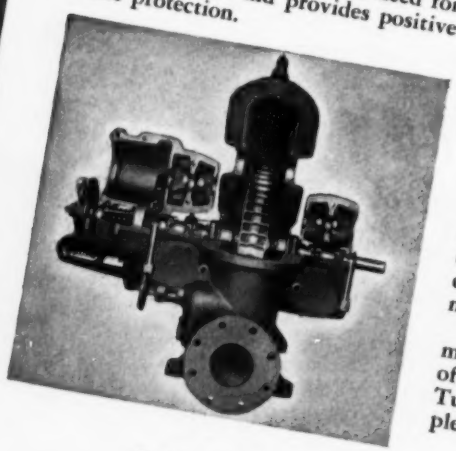
B&W REFRACTORIES PRODUCTS—B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick B&W Refractory Castables, Plastics and Mortars • **OTHER B&W PRODUCTS**—Stationary & Marine Boilers and Component Equipment... Chemical Recovery Units . . . Seamless & Welded Tubes . . . Pulverizers . . . Fuel Burning Equipment . . . Pressure Vessels . . . Alloy Castings

TERRY

PROTECTION OF TURBINE BLADES made possible by nozzle location

The Terry Solid-wheel Turbine is of the impulse, helical flow type. The steam issues from an expanding nozzle at high velocity and enters the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is returned to the wheel several times until practically all of the energy has been utilized. This principle makes possible the efficient use of steam in a single-piece, almost indestructible wheel.

In the Terry Solid-wheel Turbine, the steam enters the buckets in a direction at right angles to the shaft, as shown above. This design eliminates the need for close clearances and provides positive blade protection.



The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though external thrust should move the wheel.

This is only one of the many important features of the Terry Solid-wheel Turbine. Write for complete details.

TT-1195

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

Memo

Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.

JOHN ZINK

JZ Combination Gas and Oil Burner

SERIES CBM

Provides better combustion with either gas or oil or combination firing, heat pattern is approximately the same with each fuel. Sizes CBM-12 to CBM-30. Also available for forced draft operation. Can be furnished for horizontal firing (as shown) or vertical firing.

The John Zink Series CBM burner combines the high efficiencies of the well proven John Zink BI-MIX Gas Gun and the steamizer type MS Oil Gun. A special tile and register design permits operation at low excess air.

The CBM will handle any gaseous fuel at pressures in excess of 5 lbs., and any commercial grade of fuel oil delivered to the burner with a viscosity of not more than 25SSF.

John Zink and his engineers manufacture more than 50 types of gas burners, oil burners and combination burners for domestic boilers, heating boilers, industrial boilers and power boilers.

Remember John Zink also designs smokeless Field Flare Burners and Direct Fired Air Heaters.

Write for Bulletin CBM.

Another JZ Heat Maker

JOHN ZINK CO. 4401 So. Peoria Ave. TULSA, OKLA.

"For high dust collection efficiency CONSIDER THESE FACTS!"

95% to 99% REMOVAL

Your specific needs determine the exact percentage of fly ash removed by a Research Corporation Cottrell Precipitator.

LOW DRAFT LOSS

The pressure drop between inlet and outlet of the Cottrell is extremely low, averaging *only a few tenths of an inch of water.*

DURABILITY

Low velocities hold abrasion to a minimum.

ANY CAPACITY

Cottrell precipitators have been used successfully with both small boilers and the very large boilers developed in recent years.

OTHER APPLICATIONS

Cottrell precipitators have wide application in the recovery of other materials such as acid mist, blast furnace dust, sodium salts, fluid catalyst and valuable metals from smelters.

YOU GET all these important advantages PLUS Research Corporation's 38 years of experience in the field of electrical precipitation. Every Cottrell installation is individually engineered to do the most efficient job. For more facts about Research-installed Cottrells, send for Bulletin 500.

RESEARCH CORPORATION

405 Lexington Avenue, New York 17, N. Y.
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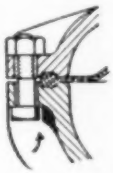
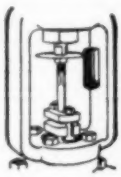
Single wrench maintenance

check these time and money-saving maintenance features

1 **CAST FLATS** make bolts easy to remove on superstructure. Heads can't turn . . . only one wrench needed.

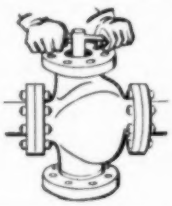


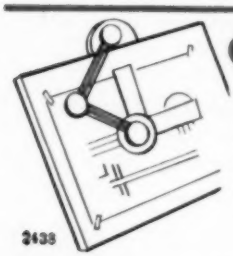
2 **WIDE YOKE**—plenty of room for big hands to work with that one wrench.



3 **FLATS** on valve stem use same adjustable wrench—does not score stem.

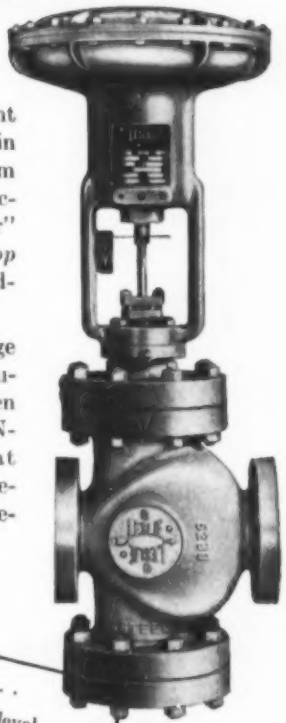
4 **SEAT RINGS** can be renewed without taking the valve body from the line. No vises, no lathes. Standard Leslie practice for 27 years, not a theory, a proven fact.





5 **INTERCHANGEABLE** parts keep inventory small, reduce down-time. Top grade materials and engineering means less maintenance.

2438



There are a host of important features found as *standard* in Leslie Double-Seated Diaphragm Control Valves usually manufactured only in "made-to-order" units — features that mean *top* performance and *extra*-dependable service.

But here's one more advantage that makes Leslie the most popular valve with maintenance men —SINGLE WRENCH MAINTENANCE. They find that maintaining the Leslie Double-Seated Control Valve is a one-tool job.

WHEN SPECIFYING . . .

for pressure, temperature and level controls, a quick check can prevent ordering a *special* that Leslie makes as *standard*. A call to your Leslie Engineer, before you specify, is free insurance. He's listed under "Valves" or "Regulators" in the classified telephone directories in principal cities.

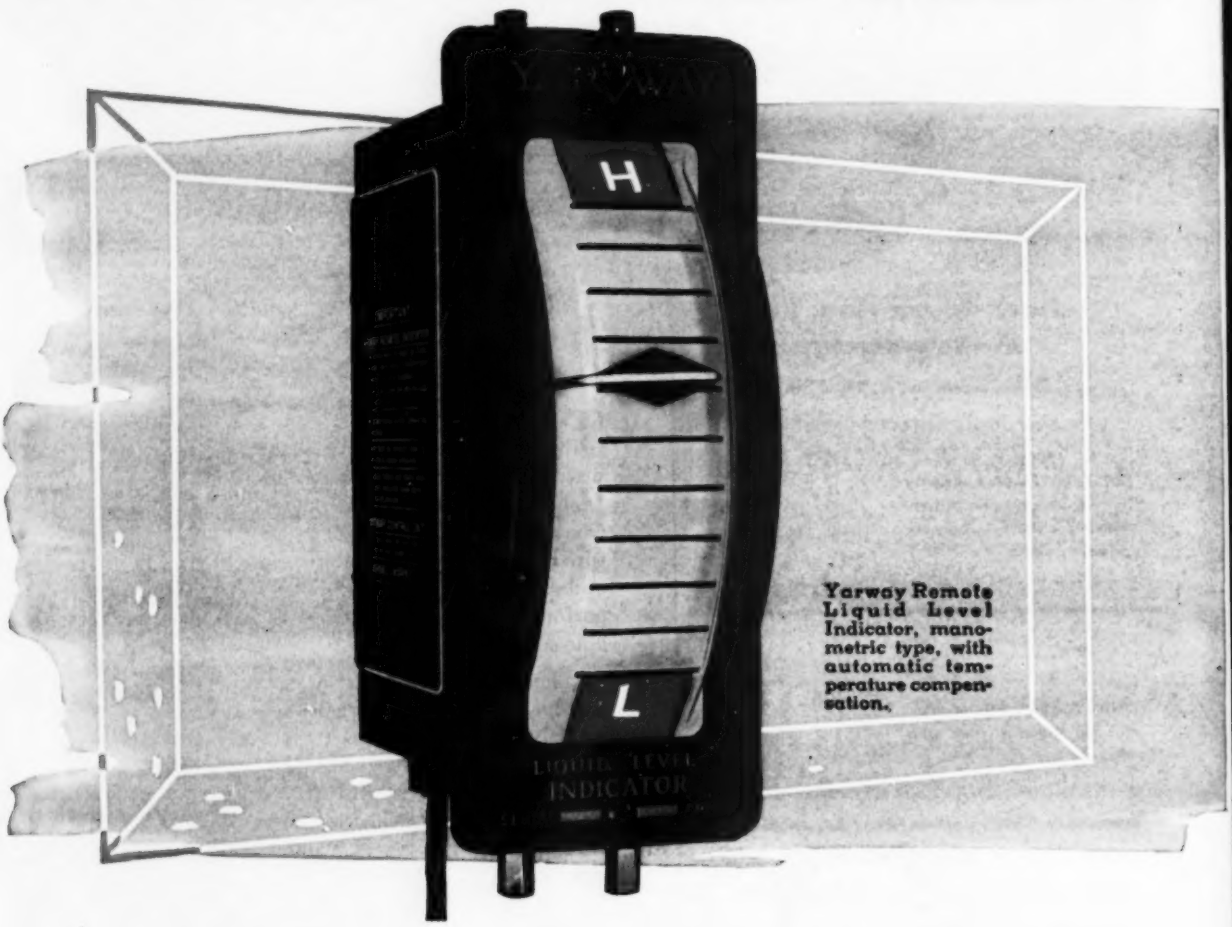
Send for free Bulletin 5305

12 new pages of valuable data on double-seated diaphragm control valves.

TRADE LESLIE MARK

LESLIE CO., 263 GRANT AVE., LYNDHURST, N. J.

What's New
IN BOILER WATER LEVEL INDICATION?



Yarway Remote Liquid Level Indicator, manometric type, with automatic temperature compensation.

IMPROVED *WIDE VISION* REMOTE LIQUID LEVEL INDICATOR

A new-type face on the Yarway Remote Liquid Level Indicator now permits side as well as head-on dial readings. This vastly improved visibility makes it possible to check boiler water levels from most any position in the control room, or wherever the Yarway Remote Indicator may be installed.

MANOMETRIC TYPE

The Yarway Indicator is a manometric type with automatic temperature compensation. Level readings are instant and accurate because the indicator is operated by the boiler water itself. The indicating mechanism is never under pressure. There are no stuffing boxes.

Over 8,000 Yarway Remote Liquid Level Indicators are successfully operating throughout industry—primarily for indicating boiler water levels, but also for many other liquid level applications, and for superheater pressure differential indication aboard ship.

For full information on Yarway Indicators, write for Yarway Bulletin WG-1823.

YARNALL-WARING COMPANY • 109 Mermaid Avenue, Philadelphia 18, Penna.

YARWAY *STEAM PLANT EQUIPMENT*

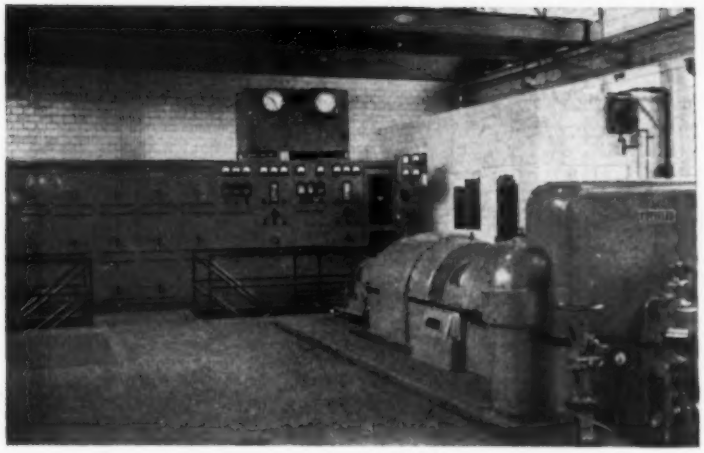


Fig. 1 — Power supply stability is only one factor in keeping hidden losses to an economically feasible minimum.

HAROLD E. McCONNELL
Consulting Engineer

Management and Engineer Search for

Hidden Losses From Electrical Systems

ECONOMICS of plant management and operation involves careful weighing of all manufacturing costs of a finished product against gross selling price. For the entire plant many costs are predictable and under the control of engineering or management before the plant is built. Some may have been treated as minor quantities that are legitimately negligible under the expected price structure because they still allow a very desirable profit ratio. If competition or changing business conditions begin to lower the profit ratio, however, it is well to re-examine systems and operations for losses.

Some of the losses may not appear in cost accounting studies. If they do, they may not be readily attributable to the real causes. These are termed "hidden" losses because they are obscured by direct losses and appear to be a part of fixed operating overhead. In technical operations, however, hidden losses are easily identified as to cause and effect. Expert engineers can usually predict what will happen when physical laws are applied under known conditions of plant operation. In many cases, hidden losses can be easily corrected; it remains merely to determine whether cost of corrective methods will result in a worthwhile savings to operating costs.

The electrical system might be called the heart of the average plant, supplying the energy which performs most of the useful work. If the system is ailing or inadequately designed for its present purpose, it can cause many insidious losses to which the finger of cost accounting probably will not point. Some of the more important ones are listed in the table below.

There is no set rule for relative importance of the losses, but they are listed in the order of descending importance for the average plant.

It is significant that much talk and some corrective effort usually centers around Item 7, but in the opinion and experience of the author, *this is frequently the smallest loss.* Cost of one accident or unexpected interruption of production may far exceed the maximum possible annual savings in power purchase price.

Of course, it is worthwhile to correct the obvious when it can be easily done and will bring a worthwhile savings at low investment cost. Furthermore, the causes behind the losses listed are usually overlapping. Sometimes the best single thing that can be done to partially correct Item 7, for example, is to improve power factor, bringing immediately reduced power bills. However, the intent of this discussion is to focus on important aspects which remain hidden to non-technical eyes.

All losses listed are directly or indirectly related to the electrical system as a whole—not merely the primary substation, switchgear, and transmis-

HIDDEN LOSSES CAUSED BY INADEQUATE ELECTRICAL SYSTEMS

1. Interruption of production and loss of raw materials due to unexpected power failures.
2. Interruption of production and excessive equipment replacement costs, due to electrical failures and damage to equipment.
3. Excessive maintenance costs.
4. Accidents to personnel and equipment.
5. Insufficient reserve power availability at points where it is needed, when it is needed.
6. Inefficient use of personnel due to failure to utilize modern automatic controls and signaling methods.
7. Excess cost of power over normal rates.
   a. Heat conversion losses.
   b. Utility penalties on poor demand and power factors.

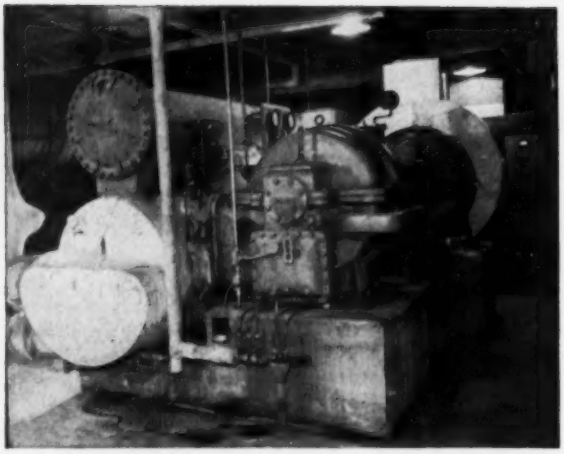


Fig. 2—Losses and reduction in capacity of driven equipment may be large compared to those in electrical systems, including motors. Air conditioning equipment is shown here.

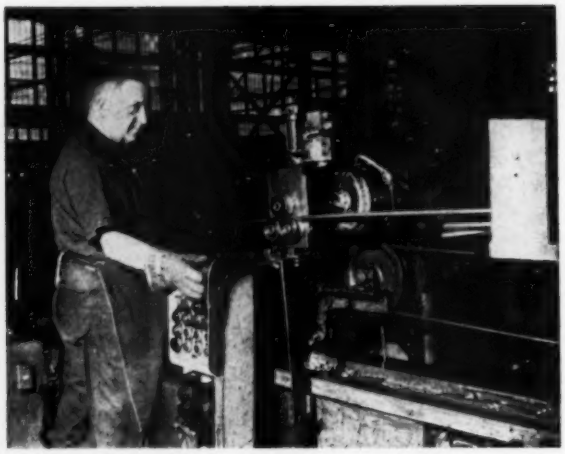


Fig. 3—Conversion to a higher system voltage increased production and equipment life and reduced maintenance for this draw bench for tubing and for other plant operations.

sion lines, but every branch feeder, motor, and other items of electrical equipment as composite parts of the system.

The mechanical load of a plant is really the most important part of the electrical system. But simple calculations allow the electrical engineer to find electrical ratings of equipment required. He too seldom bothers to explain to management that he is talking in terms of physical work as much as if he used the more common mechanical engineering terms.

Any power system must be judged by each of three criteria:

1. Ability to control and maintain the proper flow of work energy
2. Ability to carry the required amount of energy without damage to itself
3. Ability to retain stable conditions of voltage, frequency, and phase relationship between minimum and maximum power demands of the plant.

Before discussing the important but less obvious losses, it may be well to consider the more immediate causes and effects if the system is inadequate on any or all of these three points.

Avoiding Damage and Outages

Control of power from the standpoint of initial cost is concerned first with capacity of source, and secondly with the plant demand for work energy. The two are related because a plant with large demand cannot be adequately served from a utility line of low power capacity. On the other hand, the only available source of utility power for a small plant may be a high capacity line. In any case, the control switchgear and other components must be able to restrict power flow, even in a plant with relatively low demand.

A short circuit in a plant is an invitation for unlimited power flow. With the system connected to a line of a million horsepower capacity, very nearly that much power will flow towards the short circuit. The control must be able to restrain and interrupt the power, avoiding damage to all equipment in the flow path.

Fortunately, transformers and transmission lines have some restraining power impedance, and control switchgear may be progressively smaller size and expense if it is economically possible to cascade the equipment in the path of power flow. The power control method also has the task of isolating faulty equipment so that repairs may be safely and quickly performed while allowing the rest of the plant to resume normal operations. Thus loss of production and maintenance time, reduced damage to faulted equipment as well as to unfaulted equipment in the path of power flow, may be realized by the proper selection of power control methods.

Power Capacity and Losses

Ability of a system to carry power depends on internal temperatures of component parts when handling normal amounts. At normal power rates, no electrical limitation exists. Power handling ability is a thermal rating, based on the amount of heat which can be radiated and convected away without overheating the parts. No equipment can transmit all the work energy it receives, but dissipates part of it in the form of heat energy.

Electrical conductors guide energy to the right places, but they also convert some of it to heat energy. The better the material as a conductor and the greater the cross section, the less is the heat loss. But practical economic limits exist as to the kind and quantity of material that may be purchased to avoid minor heat losses. Copper is widely used because its conductivity is quite high, and it is relatively cheap. Aluminum is good, and as it ecomes cheaper, it may often become a better buy than copper.

Losses from Heat

Heat is the greatest enemy of electrical equipment. For one thing, all good conductors have rather low melting points. But even more important, insulating materials are needed. Their life is seriously affected and they are sometimes permanently damaged by temperatures far lower than conductor fusion temperatures. If insulation fails, the equipment is as surely out of operation as if the conductor had melted.

Furthermore, heat losses represent power paid for but not delivered to machine shafts for useful work, nor is the heat available for economic recovery into useful applications. Total heat losses in a well designed plant, including transformer losses, line losses, and motor losses, may run from 15 to 18 per cent of the total monthly power bill. In a poorly designed system they may run much higher, often as high as 30 per cent.

Electrical heat losses are here to stay; they can be reduced, but not eliminated. Few engineers really examine their cost, but it is seldom economical to try to reduce them below a reasonable percentage. Certain rules of thumb used in system designs almost automatically produce an economical design with respect to losses, even though primarily used for other reasons. For example, the proper system will allow operation of motors at their

maximum efficiency, which is limited by manufacturing design problems. Therefore, excessive heat losses should be considered primarily as the cause of possible deleterious effects on equipment life.

Heat losses in equipment increase exponentially with increased power demand, Fig. 4. The mechanical load in a plant always has some tendency, furthermore, to upset some elements of the system stability (such as voltage, power factor, and sometimes frequency) particularly if the system is not well designed for the load. When this occurs to a serious extent, heat losses in each piece of equipment increase still more (resistance increases with temperature, motors are less efficient at low voltage, and so on).

Many non-electrical factors also affect internal temperatures (and therefore life) of electrical equipment even though handling normal amounts of power with normal system stability. An example is ambient temperature which, when high, forces equipment temperatures higher to maintain rate of heat dissipation.

Moisture is the second great enemy of electrical equipment because it attacks the properties of most electrical insulators. Furthermore, chemically polluted or dust laden atmospheres greatly increase activity of moisture in attacking insulations.

Stability Factors

Ability of the system to remain stable involves rather complicated design problems for the technical specialist. At some expense, all of these may be accurately controlled within suitable limits for the range of power needed, and for the nature of the mechanical load.

Fortunately for the small and medium sized plants which find it more economical to buy power, the problem of frequency stability is assumed by the public utility companies. They normally maintain frequency stability far better than that needed by the average plant.

The utility also customarily assumes some degree of responsibility for maintaining certain standards of voltage and phase stability at the customer's service entrance. But the better these standards are, the higher the capacity of the utility line must be, thus affecting the power control requirements at the service entrance of the plant.

The plant system itself inherently contains many additional problems of voltage and phase variations which are always additive to the tolerance maintained at the service entrance. Furthermore, unless sufficient liason is maintained with the utility company during design or modification of a plant for increased power requirements, it may be unable to maintain its own standards of regulation at the service entrance. Any system—plant or utility—must be designed within specified limits of maximum to minimum power estimates to permit economical design and avoid unnecessary losses. It is not technically possible to design a system for perfect stability under all conditions nor is it economically desirable.

Instead, systems are designed for certain useable tolerances of variation around a stable reference point, arbitrarily picked for the particular system. Amount of variation is called the regulation of the system. The term most commonly refers to voltage regulation, but it is used here to include variations from references needed in good electrical design.

Electrical manufacturers design equipment to operate satisfactorily and with long life under specified conditions. Electrical equipment has, if operated within specified limits, as long or longer life than any other equipment in the plant and is usually superior to the mechanical equipment driven by it.

Manufacturing defects occasionally occur, but the plant which has an abnormal rate of electrical equipment failures should hesitate to blame the manufacturer. Failures are more likely caused by conditions in their electrical system. Chemically corrosive action and extreme vibrations are non-electrical causes, but they are not the rule.

Abnormal failures can nearly always be traced to the electric system itself or to improper operation by personnel and management. Management often demands that certain equipment operate under conditions for which it and the system were not designed. Sometimes it is justifiable for temporary periods, but the practice should be carefully weighed against the previously listed losses which will inevitably occur.

Operation vs Losses

Improper operating sequences designed into a plant or deliberately imposed by operators place duty cycles on motors and controls outside the original design limits. These are good examples of causes of hidden losses which can usually be corrected quite easily by re-design of motor control methods and education of operators.

Corrosive atmospheric conditions, heavy accumulations of dust or moisture, and unusually high ambient temperatures are external conditions under which electrical machinery often must operate. At somewhat greater expense, a system can be designed for good reliability and operating economy under these extraordinary conditions. Failure to do so usually means losses far in excess of the higher fixed charges of the properly designed system.

Improper application of the mechan-

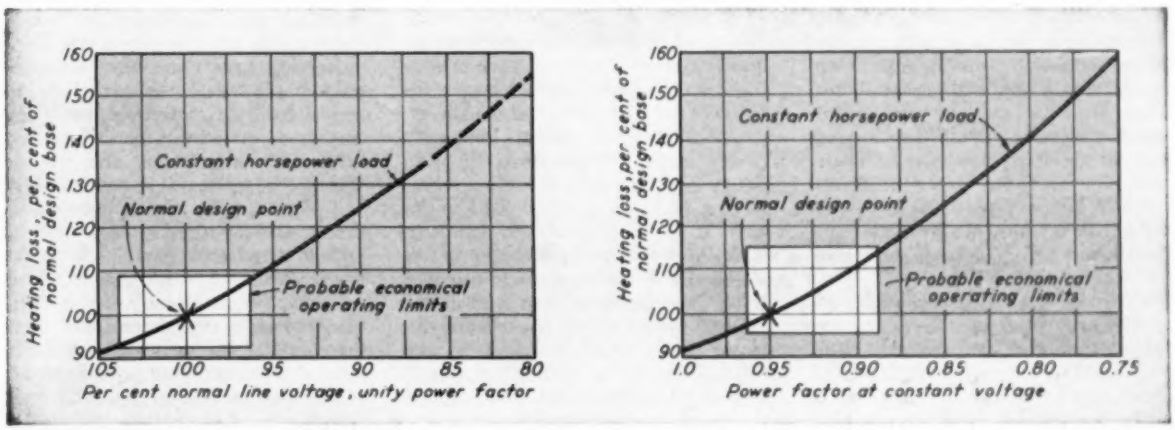


Fig. 4—These curves illustrate variation of heating loss with two electrical system stability factors, voltage and power factor. They apply primarily to the power handling equipment such as cables and breakers; other factors may affect motor and transformer efficiency. The effect of varying load is not taken into consideration in the curves.

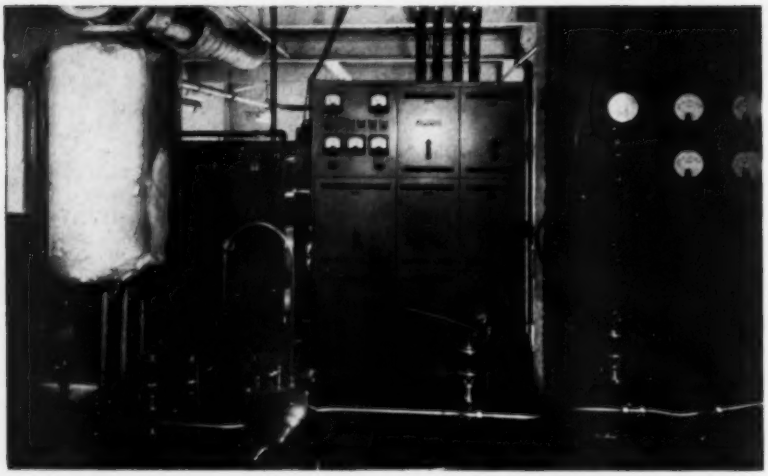


Fig. 5—Modern distribution system design has done much to reduce direct system losses, too often neglected because power is cheap. In part, however, direct losses are a measure of greater losses in investment, depreciation and production.

ical load (underload, overload, excessive variations, and the like) to an electrical system aggravates its natural tendency to upset the system regulation, causing excessive voltage variations, phase unbalance, and low power factor. Nevertheless, since thermal, rather than electrical limitations apply, the equipment will deliver all of the useful energy demanded by the shaft, but not within rated thermal specifications.

Excessive heat reduces life of the equipment and causes abnormally high replacement rates. Correction to suitable limits at once restores normal thermal ratings, but damage present cannot be undone. Plants seldom operate with conditions so bad as to destroy a machine immediately. However, its life expectancy will be permanently reduced.

Life Expectancy

Exclusive of mechanical wear, induction machines ought to have a useful life expectancy of over 20 years if operated within specified design limits. There are many instances on record of actual equipment life of 40 to 50 years without excessive maintenance. Therefore, if a plant has experienced consistently high equipment failure rates, the trouble is almost always in the plant system and in operating procedures and sequences.

Long life is not necessarily built into electrical equipment designed for frequent mechanical action. Circuit breakers, contactors, switches, and commutators involving mechanical action are subject to friction and to wear on electrical parts. However, experience bears out the perfectly reasonable assumption that if abnormal failures occur in motors, abnormal failure rate of control equipment will probably occur because operation occurs under more severe electrical conditions than would occur in a well designed system. Conversely, abnormal failure rate in control equipment indicates impending abnormal failures in induction equipment operating near the nominal rated shaft output.

Importance of System Design

A detailed description of many other losses and the explanation of the engineering reasons for them fills volumes of handbooks and texts. Some are so minor as to warrant little attention. Some major losses, including a few listed at the start of this discussion, are so obvious that they need little description. The purpose of this discussion is to show, in non-technical terms, that electrical engineering is a fairly exact science which allows predictable results when conditions are known or anticipated. Seriously excessive operating costs can be avoided by proper relation of the science to plant economics.

Good electrical system design is closely coupled to good over-all plant design even though technically it represents a highly specialized field of its own. It is not sufficient to calculate brake horsepower requirements of an electrically driven mechanical machine and order a motor to the nearest nominal horsepower rating. Selection of the motor should be subject to review and coordination by a qualified electrical specialist who has full knowledge of the system in which it will operate.

Comparison of speed-torque curves of the mechanical load to those of the motor is only one of several highly important points for correlation into the system. Electrical manufacturers do their best to aid and guide plants into proper selection of equipment; they cannot do the job alone nor can they afford to violate the legal and ethical principles of good engineering. Only the competent and experienced staff electrical engineer or consultant has both time and information to properly integrate all such matters into a composite system.

Even a good system can become inadequate and costly if load requirements exceed the original design limits. The practice of "hanging load" onto an existing line, if done without good technical advice, can be a very costly matter in terms of upsetting system stability and reducing equipment life, though it may be the only feasible thing for a temporary period.

Predicting Future Losses

Many plants are so well designed that they have no excessive hidden losses. Others may have accounting methods which remove all major losses from the category of "hidden" losses, but this does not guarantee that they are not "excessive" costs. A thorough study and analysis of the system by a competent engineer can reveal whether a plant has hidden losses or not. Such an analysis can show the dollar cost of certain losses, and can predict others.

Usually, predictions are not convincing to management unless accounting costs presently reflect the losses. For instance, in the plant with fixed charges based on a 20 year depreciation rate, it may be possible to predict with rough accuracy that actual depreciation will give approximately half useful life, or only 10 years. A plant only 5 years old may not have begun to feel the dollar cost of the accelerated depreciation rate, and the engineer may have difficulty getting acceptance of the technical prediction because "everything is fine now."

Kelvin's Law states that the most economic installation is that where the annual fixed charges equal the losses. Interest on investment, depreciation on a fair and normal basis, and pro-rata share of plant management overhead and property taxes may be properly regarded as fixed charges. Losses should include the seven shown in the box at the beginning of this article. Total costs may be pro-rata adjusted to various production departments, but since the electrical system is a conveyor for the useful process energy, cost of power and strictly production overhead costs cannot be used as cost figures applying to the electrical system.

In a hypothetical plant with $1 million installed electrical equipment cost,

fixed annual charges might be determined as follows:

Interest—5% on $1,000,000	$50,000
Depreciation—4% for 25 yr life	40,000
Pro-rata share—plant overhead and property taxes	30,000
Total fixed charges	$120,000

Such a plant, if operating on a 24 hr per day, year round basis, might easily consume an average of 5000 kw for 8000 hr per yr (or 40,000,000 kwh per year as metered at the service entrance). At 80 per cent over-all electrical efficiency (including efficiency of motors, but not mechanical efficiency of driven equipment) annual cost of heat losses is approximately $80,000, assuming the cost of power at 1¢ per kwh after applying penalty rates, fuel clauses, and the like. If power factor is low, an additional amount of penalty, as an overcharge against the 80 per cent of useful power transmitted, is chargeable as a loss to the electrical system.

These figures are for illustration only. However, if it is desired to operate within Kelvin's Law of economics, they leave only $40,000 or less to cover maintenance department budget, purchase and storage of spare parts and attendant pro-rata share of administrative and engineering overhead, as well as any other excess costs (hidden or otherwise) such as accelerated depreciation of equipment, interruption of production, and accidents and emergency repairs.

Over-all plant electrical efficiency cannot be successfully increased above 85 per cent for most average plants, but many plants operate as low as 70 per cent. This would increase the heat loss costs to about $120,000 per year, and, no doubt, further increase penalty rates on the entire power bill. With low efficiency, half-life mortality of equipment rather than the fair life assumed under fixed charges may be experienced, adding a loss of $40,000 per yr more because it exceeds fair depreciation under good system conditions.

In the preceding example, total of the heat losses resulting from the use of electrical power to produce mechanical work was intentionally classed in the total loss column. In some cases, it would be possible and even justifiable to regard the minimum possible heat losses (about 15 per cent) as a fixed charge against power use, and regard only the excess above the minimum as a charge to the loss column. However, the principal effort here is to uncover the actual cost of using power. Electrical efficiency of equipment is normally high, but many people forget that losses, from primary substations down to and including utilization equipment, cascade and result in a much lower over-all efficiency.

Penalty rates due to demand factor may not be directly chargeable to the electrical system, because they may be caused by process requirements which system design cannot change. However, good engineering design, in cooperation with good management planning, can sometimes improve a poor demand factor without much spending.

Actual costs of interruption to plant production vary considerably. They may even be quite negligible in the plant operating at much less than 100 per cent capacity and having no process causing non-recoverable loss of raw materials due to power failure.

On the other hand, cost of an unscheduled loss of power lasting over 30 min but less than 4 to 5 hr is said to be in the neighborhood of $50,000. This same plant operates on a 24 hr basis at nearly full capacity, with present production rates barely able to take care of sales. Outages lasting more than a few hours might have to bear the entire cost of operating overhead.

In another plant, operating at reduced capacity, one particular process was installed with equipment not suitable for the extremely corrosive conditions. Too much maintenance, under very difficult conditions, is necessary to keep the equipment operable, though temporary losses of production do not seriously affect plant overhead and production costs.

Some plants depreciate production equipment in a very few years which, under Kelvin's law, may be the most desirable. To make such a plant pay out in a few years, it must produce on a predetermined schedule. This may require maximum performance from electrical machinery, and maximum reliability of power flow.

With electrical equipment, maximum performance and dependability usually can only be achieved when the system operates within specified limits. However, equipment so operated should have a fairly long life expectancy. This is as it should be. If the electrical system depreciated as fast as a particular process plant unit, it would be unable to supply power for lighting and air conditioning, for construction of a new unit, or to reliably serve the new unit after it is constructed.

Searching for Hidden Losses

Two methods are available, but each should be used with the other when possible. One is to have a thorough engineering analysis made, preferably over a period of several months. This sheds insufficient light on past experience, but it may uncover facts about present and future operations.

The second method is to establish cost accounting records which will reflect the formerly hidden losses in their true light. This may mean a dual set of accounting records to record electrical costs as a part of plant production overhead costs—not as difficult as it may sound. If electrical costs are separated from accounting charges (in which they might become "hidden") so that necessary balances are available, simple journal entries can be made to transfer total dollar costs, on a pro-rata share, to any production account desired. It is an exceptionally convincing method of portraying actual costs, but is not always accurate as to cause. Until personnel learns how to investigate and analyze actual occurrences, many false costs may be introduced due to human error. But assistance of a good technical engineer with some knowledge of cost accounting will help establish proper causes.

Any plant should be able to reconstruct the capital cost and fixed charges on its electrical system, even if accounts are not presently so maintained. It is more difficult to reconstruct past experience on electrical operating costs (although it can be done with fair accuracy) but present costs are rather easily obtained. They should include the entire budget for the electrical maintenance department, emergency repairs, outside maintenance contracts, procurement and storage of spare parts and equipment, a fair share of administrative and engineering overhead, miscellaneous losses from production interruptions and accidents, and heat losses. In the absence of specific engineering information, heat losses should never be assumed as less than 20 per cent of the annual power bill.

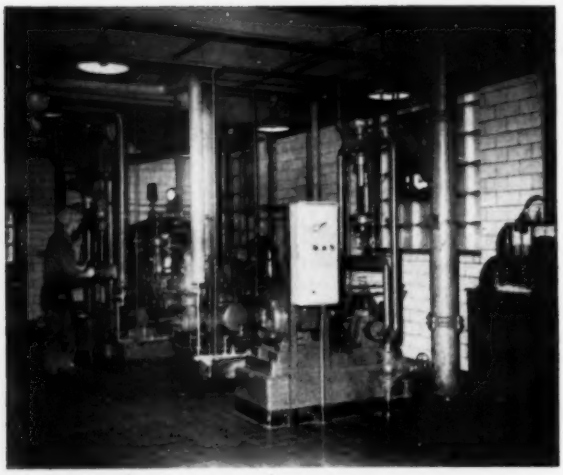
Avoiding Losses

Cost figures thus obtained would be immensely valuable to management and engineering alike. Engineering can do a better job when it can relate exact laws to facts of dollar cost. Good engineering must not be reduced to "guesses" or to intuition, when facts which will help to improve plant profits and operational methods are available.

The application of Kelvin's Law of economics to component parts of a plant, such as the electrical system, is merely an extension of commonly used principles over the middle range. Over-all plant design is usually guided by such well determined mathematical principles, as is individual machine design, because in each case it means the best efficiency for the money spent.

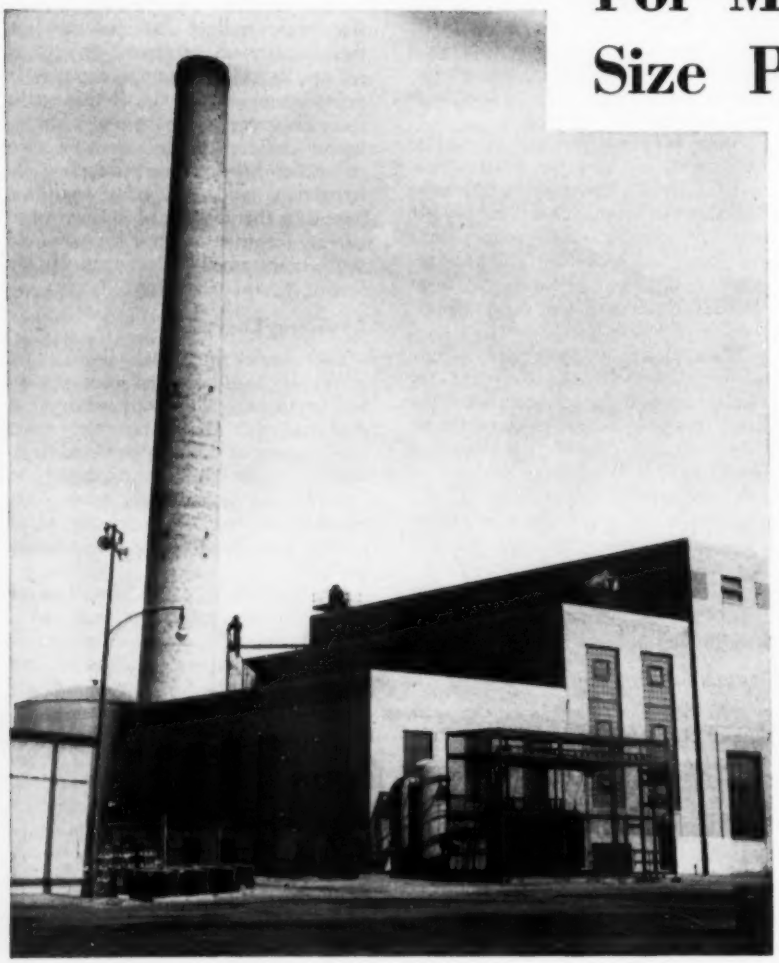
The same principles of economics apply to the electrical system as a whole, and the original estimates of over-all plant efficiency cannot be maintained unless the electrical system operates within correct tolerances.

Each steam generator has a capacity of 30,000 lb per hr. One power operated traveling weigh larry serves all three units.



Three feed pumps; one motor driven centrifugal, one turbine driven centrifugal, and one reciprocating, serve the boilers.

Perfection Stove Builds Power House For Model Medium Size Plant



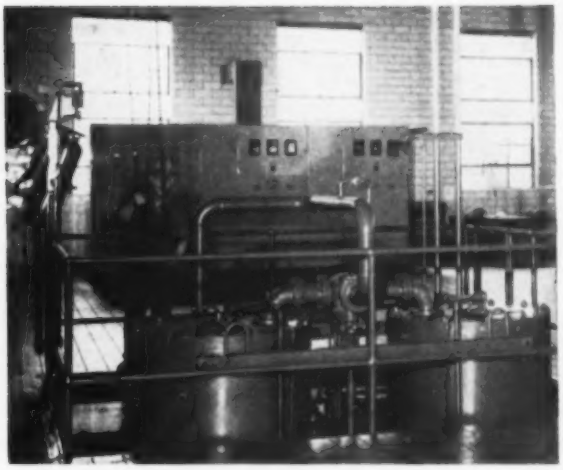
Exterior photo shows Perfection Stove's million dollar steam generating plant.

WALTER RUDOLPH

SEVERAL years ago the Ivanhoe Road Plant of Perfection Stove Co., Cleveland, received national recognition as an example of proper medium size plant construction, an honor equally deserved by the million dollar boiler house erected just to the rear of the plant proper. Although no detailed records were maintained, for comparison between the former and present methods of operation, available figures indicate appreciable savings have been achieved by the new system.

The old power house supplied approximately 7000 lb per hr of process steam and heated a building volume of 3,220,950 cu ft. Now 15,000 lb per hr of process steam is supplied while heating a building volume of 19,553,970 cu ft. The new steam generating units satisfy both requirements and have

Additional equipment in the power house includes two 1000 cfm air compressors. Fire pump (not shown) is in this area.



Compressor air filtering and drying equipment is installed as shown. Chain fall facilitates maintenance of the units.

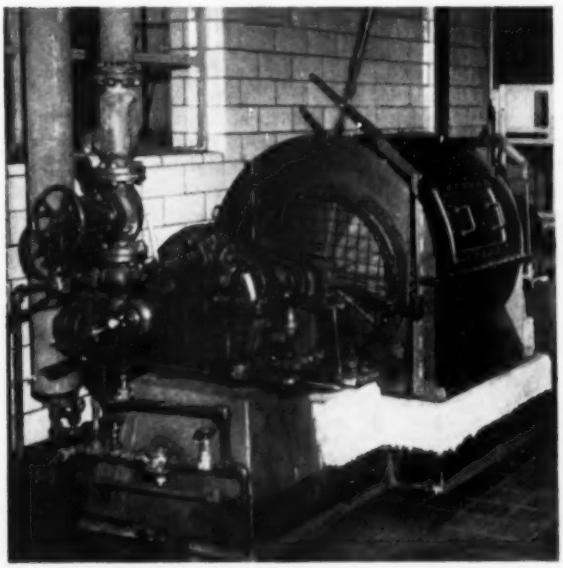
adequate reserve capacity to meet future expansion needs. Peak load to date has been about 55,000 lb per hr, or roughly four times the previous maximum demand.

From 1945 to 1947 inclusive, the old plant consumed approximately 450 tons of deep mine coal monthly during the seven month heating season. At that time, the delivered cost per ton of coal averaged $5.60. This coal would cost over $8.00 per ton today. The new power house requires about 746 tons of Ohio strip coal monthly, or less than one-half of the projected consumption rate of the former plant for comparable load conditions. Furthermore, this coal costs slightly less than $6.00 per ton.

When designing the plant, George S. Rider Co., Architects, gave careful consideration to manual labor reduction, equipment design and location, standby facilities, duplication of essential elements, and over-all efficient control. Thus, the new larger building contains air compressors, a compressed air filter and dryer, the plant fire pump, and sundry other equipment formerly lacking or located elsewhere, in addition to the steam generators and their auxiliaries. All of this equipment is operated and maintained by the power plant personnel.

The plant operates continuously 24 hours per day at all times. This makes the new power plant arrangement more advantageous to the manufacturing picture as a whole because only eight men are required in the boiler house. Each man works 48 hours weekly, the three regular firemen and helpers spending full time on operation and the relief crew dividing their time equally between operation and maintenance. This force is able to handle all work in the power plant with the exception of major repair or construction projects.

Coal is received by rail and dumped into an underground conveyor-elevator arrangement for transport to an overhead 400 ton capacity bunker. Here a



Forced draft fans are motor and turbine driven. Arrangement provides operational flexibility and improves heat balance.

Rear view of the power house shows coal handling equipment, ash silo, and water storage tank for fire protection system.

Enclosed hoppers under the boilers feed the ash conveyor recessed in the floor.

"Home-made" incinerator burns refuse; satisfies smoke abatement regulations.

drag is used to give proper distribution. In the boiler room, a traveling power weigh larry draws coal from any one of the 12 hopper openings in the bottom of this bunker and transfers it to the stoker hoppers.

Three steam generators, each designed to produce 30,000 lb per hr, were installed in the new plant. Normally one of these boilers handles the summer process load while two or three units are required during the heating season. For most conditions, one unit provides standby protection and can be placed in service when the working units require inspection or repairs.

Efficiencies of 80 to 85 per cent are obtained from these steam generators, which are designed especially to burn strip mine coal. Excess air is said to average 30 per cent, and CO_2 readings average 12 per cent. Steam aspirators give more efficient combustion by carrying overfire air to the fuel bed and creating the necessary gas turbulence in this vital area.

Sloping ash receivers directly beneath the steam generators carry ashes to a conveyor recessed in the floor of the basement ash control room. This conveyor feeds a steam actuated vacuum system that dumps the ashes into an elevated, outdoor silo. Dump trucks drive under the silo and are loaded with ashes. During construction, hundreds of tons of these ashes were used for making parking lots at the plant, and now they are readily saleable elsewhere.

Some 90 per cent of the process steam is returned as condensate through a monitor, which automatically discharges the water to the sewers if impurities are present. Makeup water is treated in a 2900 gph, hot process, lime-soda softener, supplemented by phosphate after-treatment. The feed water then flows to a common suction header that serves one steam reciprocating and two centrifugal pumps. One centrifugal pump has a turbine drive and the other is motor driven to insure maximum operating safety. In addition, city water can be supplied through a pipe connection in an emergency.

Individual, dual motor and turbine driven, forced draft fans were installed for each steam generator. These units are located behind the boilers on the operating floor and are equipped with inlet vanes for control of the combustion air volume. Incidentally, the turbine drives on these blowers give more flexibility at low demand, as the exhaust steam heats the feedwater and provides added economy.

All steam generators have feedwater regulators and fully automatic combustion controls which regulate both fuel feed and air flow in accordance with the load demand. The controls are mounted on a master control panel that includes integrating and recording flow meters for: (a) steam output from each boiler, (b) feedwater, (c) makeup water, (d) process steam, and (e) heating steam. Air compressor instrumentation and eye level water gages also were installed on this panel.

Working conditions are of the finest, with the enclosed coal bunker and separate ash room in the basement eliminating dust. Glazed tile walls and floors, locker and shower room, harmonious interior painting, and near-day-light interiors through glass-block installations all contribute to plant cleanliness. Catwalks make steam generator and piping maintenance easier than in the old power house.

The new power house heats a volume approximately six times that of the former plant and satisfies a process steam demand double the former load with only a 50 per cent increase in total fuel consumption. Strip coal is cheaper, however, and makes over-all savings possible. Estimates based on unit costs show the new power facilities provide a theoretical savings of $50,000 per year in steam costs when compared with the old plant.

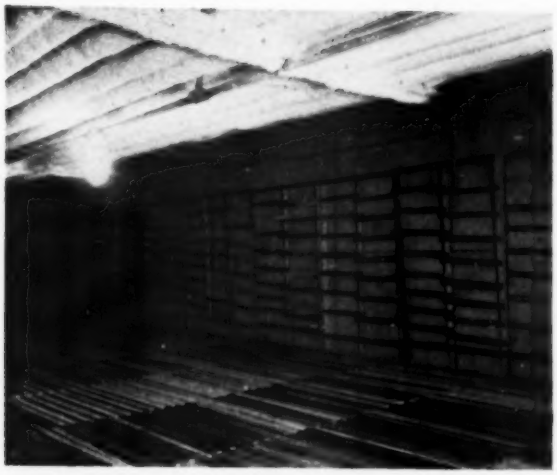
Additional equipment in the power house includes two, 1000 cfm air compressors; a compressed air filter and dryer; a portion of the main electrical switch gear; and the plant fire pump, drawing from a 200,000 gal outside tank. Compressor cooling water circulates through the fire tank during winter months, keeping it warm. A standby heating coil, with automatic controls, prevents freezing in the event of compressor shutdown.

During the plant design stage, local smoke abatement regulations insisted upon an incinerator, or a 12 mile round trip to a city dump with trash. Investigation showed an incinerator would be desirable, but costs up to $10,000 for a 2000 lb per hr unit were prohibitive. Thus, Perfection decided to build its own. Salvage materials were used, in the main, to provide a furnace roughly 7 x 15 x 9 ft with a 5 x 7 ft grate area. This unit has nine inch fire walls with a four inch common brick veneer and includes internal baffles to eliminate smoke and fly ash.

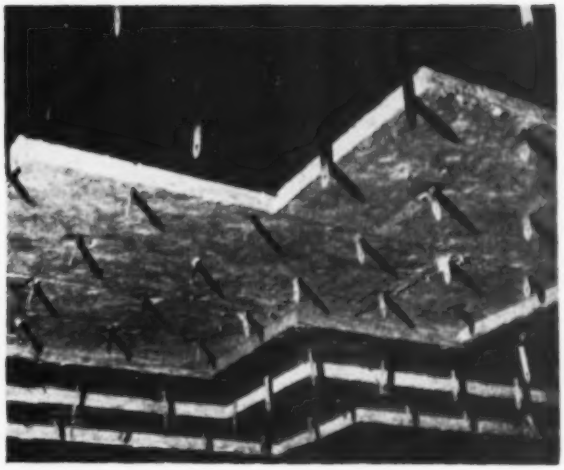
It was figured that total labor and construction costs of this "home-made" incinerator were $2393, with about $936.00 spent for purchased materials. It does a good job of firing plant rubbish with a minimum of maintenance and labor and complies perfectly with local abatement codes. Furthermore, the incinerator effects savings of $1000 annually over dump haulage costs.

PRINCIPAL EQUIPMENT

Steam generators	Combustion Engineering-Superheater, Inc.
Boiler feed pumps	Worthington Corp.
Hot process softener	Cochrane Corp.
Automatic boiler controls	A. W. Cash Co.
Boiler instrumentation	Bailey Meter Co.
Electrical equipment	Allen-Bradley Co.
Forced draft fans	Clarage Fan Co.
Forced draft fan turbines	Carling Turbine Blower Co.
Coal handling conveyors	The Jeffrey Mfg. Co.
Ash handling conveyor	United Conveyor Corp.
Air compressors	Worthington Corp.
Cut-out switches for compressors	General Electric Co.
Air filter and dryer	Pittsburgh Lectrodryer Corp.



Basement storage level at the Granite City Warehouse is held at -10F. Finish coat is sectioned in panels.



Sequence of application of the four layers of insulation on the ceiling of the Granite City Warehouse.

Cold Storage Insulation Design

JOSEPH BROW, *General Manager, Granite City Cold Storage Warehouse, Inc.*

APPLICATION of mineral wool fiber board insulation at the modern, three-level plant of the Granite City Cold Storage Warehouse, Inc., of Quincy, Mass., demonstrates advanced installation techniques designed especially for optimum insulating performance at low temperatures with the minimum maintenance expense. In the fourth year of trouble-free service, Granite City engineers report very stable storage temperatures in all seasons and economical operation of the company's refrigeration equipment.

The 100 x 25 ft building can accommodate 25 to 30 carloads of frozen foods or 3,000,000 lb of frozen fish in its three storage levels. In the basement, citrus juices, meats, or turkeys are maintained constantly at -10 F. Vegetables and fruits are kept at -5 F in the two upper levels. Interfloor conveyors at the center of the concrete floor areas speed the handling of foods between storage levels.

Eight inches of board insulation in 24 x 48 in. sections, secured by metal clips, were applied to all walls in three layers. Metal clips were applied by cementing the perforated metal base to the masonry walls on about 8 in. vertical and 16 in. horizontal centers.

Applied over the metal clips after the adhesive has dried, the vapor barrier consists of a coating of asphalt emulsion followed by a layer of asphalt-saturated paper. Cold emulsion was brushed thoroughly over the masonry surface and the bases of the clips. Paper was then impaled over the clips and carefully smoothed into the emulsion, with all edges sealed to provide a tight vapor barrier.

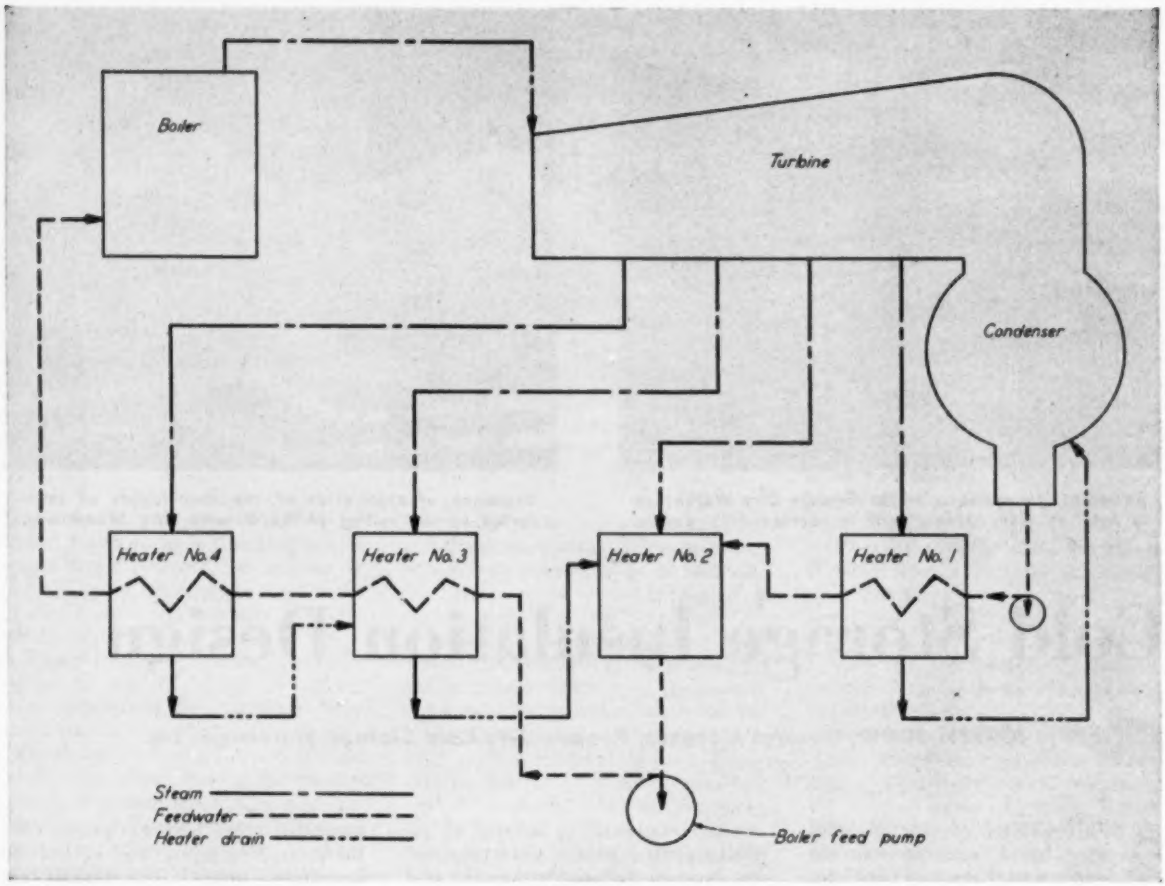
Over this vapor barrier, the first 3 in. layer of mineral fiber boards was impaled on the metal clips and secured in place by a fiber locking plate over each clip. Because the first set of metal clips secures only the first two layers, the third layer of insulation is secured by a second set of clips. The middle layer of insulation, which usually is more rigid (higher density) because of the additional load it must carry, is pierced by these clips before installation so that they will be properly located between clips protruding through the first layer. Metal holding plates are placed over the clips in the first set, and the prong ends are bent in opposite directions to secure the boards. Fiber locking plates are snapped into the locking slots of the second set of clips at the outer surface of the middle layer of insulation.

Third and final layer is then impaled on the second set of clips and is temporarily held in place by bending only one prong back. The sections in each layer are staggered so as not to align edges. As a key for the finish, expanded metal lath was placed over the protruding prongs and against the insulation surface. The prongs are bent over to secure the lath, and the insulation is ready for finishing.

Walls were finished with two coats of Portland cement plaster. First, a ½ in. thick scratch coat was roughed into the expanded metal lath and allowed to dry. A ¼ in. thick finish coat was then troweled on to provide a smooth surface. The finish coat was sectioned in 4 ft squares to localize shrinking and thus minimize cracks.

Boards were secured to the ceiling by metal clips in the same manner as the walls. However, a total insulation thickness of 10 in. was specified to insure proper storage temperatures and economical operation even during the hottest summer days when the heat absorbed through flat tar-and-gravel roof is tremendous. The insulation includes one layer 4 in. thick and three layers of 2 in. thick. Rather than a plaster finish over expanded metal lath as on the walls, the ceiling was finished with a ⅛ in. dry coat of asphalt emulsion trowelled over the surface.

Automatic operation of the refrigeration equipment is based on a 5 x 5 in., 15 hp unit, which carries the continuous load. For heavy refrigeration loads, a 6 x 6 in., 25 hp compressor unit automatically cuts in when refrigeration pressure drops below 5 psi.



Schematic diagram shows typical feedwater heating system. Calculation procedure for determining extraction flows and numerical examples are based on this layout but can be applied to alternate heater arrangements.

Feedwater Heating Calculations For Steam Turbines

NOMENCLATURE

- W = feedwater entering heater, lb per hr
- S = heating steam to heater, lb per hr
- W_c = flow from turbine to condenser, lb per hr
- W_2 = additional sources of heat or additional quantities of water to be heated, lb per hr
- H = enthalpy of heating steam, Btu per lb
- h_s = enthalpy of saturated liquid in heater, Btu per lb
- h_1 = enthalpy of feedwater entering heater, Btu per lb
- h_f = enthalpy of feedwater leaving heater, Btu per lb
- h_2 = enthalpy of additional sources of heat or additional quantities of feedwater, Btu per lb
- θ = terminal temperature difference, deg F
- d = heat loss external to heater, Btu per lb

E. V. POLLARD
Section Engineer
Turbine Engineering Division
General Electric Company

ENGINEERS and operators in the field have asked that feedwater heating calculation "know how" be made available in convenient form. The apparent complexity of multistage extraction for feedwater heating has discouraged many potential calculators, but the over-all problem is greatly simplified when the system is broken down, and each heater is considered separately.

In this article, a four heater diagram calculation procedure is set up, a series

of calculations are made at fractions of load, and explanatory notes are included where variations from the procedure are made.

With characteristic data for the turbine at hand, the first step is to work up the calculations. The procedure shows each step of the heat balance calculation as the feedwater moves from the condenser to the boiler. It defines each step, gives the source of data, or indicates the operation performed to obtain the particular item.

No. 1 Heater

Examination of the heat balance diagram shows that the first heat exchanger the feedwater passes through is the No. 1 heater. An algebraic heat balance is made for this unit, which simplifies to the following equation for extraction flow from the turbine:

$$S = \frac{W_c\,(h_t - h_1)}{(H - h_a) - (h_t - h_1)}$$

By a simple substitution, the quantity S has been subtracted from the feedwater flow so that all data on the right side of the equation are values which can be found directly. Note that the quantity W_c is the pounds flow from the turbine to the condenser.

When the flow to the following stage at an extraction point is known, the pressure and enthalpy at this point may be read from the characteristic curves for the turbine. Then with a selected pressure drop to the heater, the heater pressure becomes known, and both heater temperature and enthalpy are found from steam table data. Next, with data for the terminal temperature difference and condenser back pressure available, the enthalpy values of the feedwater entering and leaving the heater are determined. This completes the data required to solve the heat balance for the unknown extraction flow.

The calculation procedure records each of the above steps in logical order. It is prepared before any numerical calculations are made and should be used primarily as a reference. Work sheets for making calculations should include columns for line, symbol, and source before any figures are determined, but the column marked "Description" may be omitted. Reference to the sample calculation will show that computations for a number of loads may be made on the same sheet as long as the data for a given step depends on known data or on a preceding step.

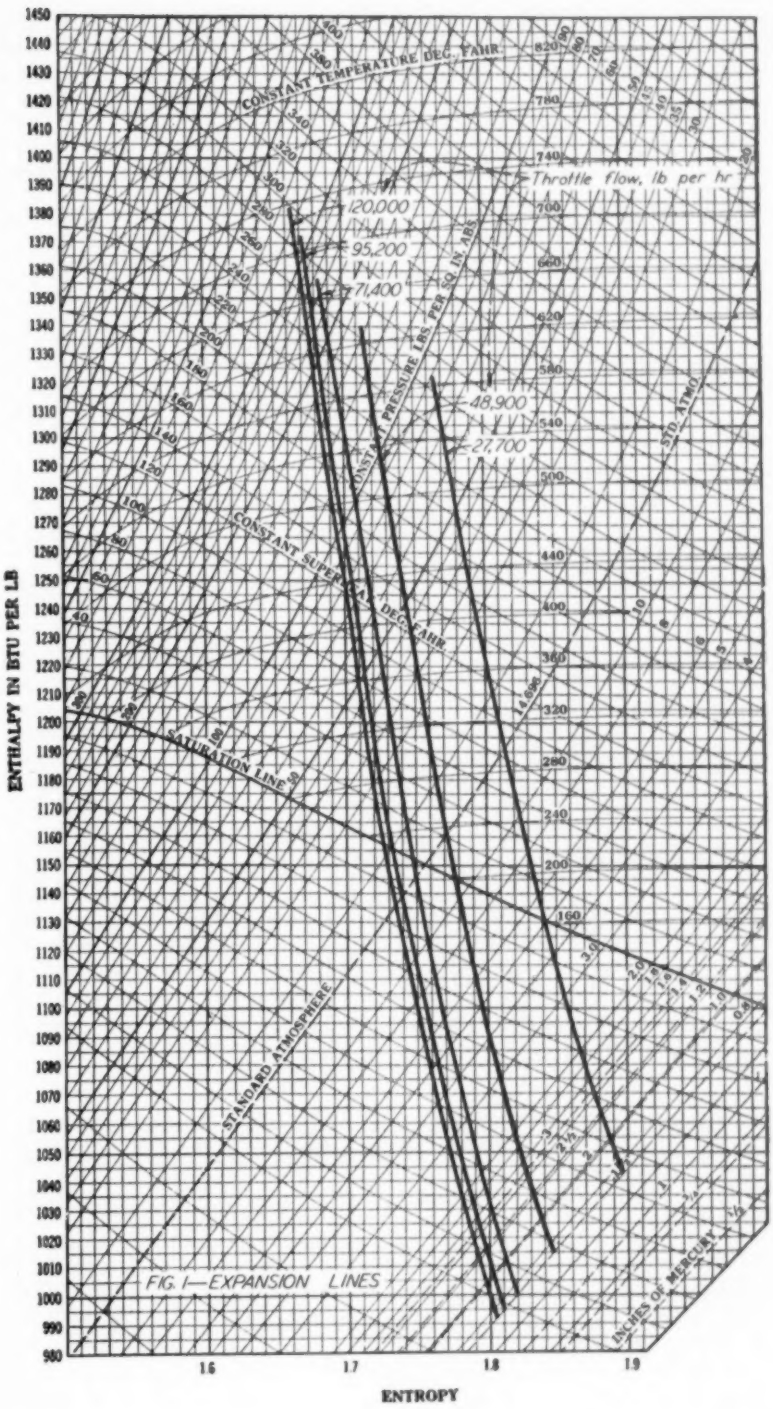
No. 2 Heater

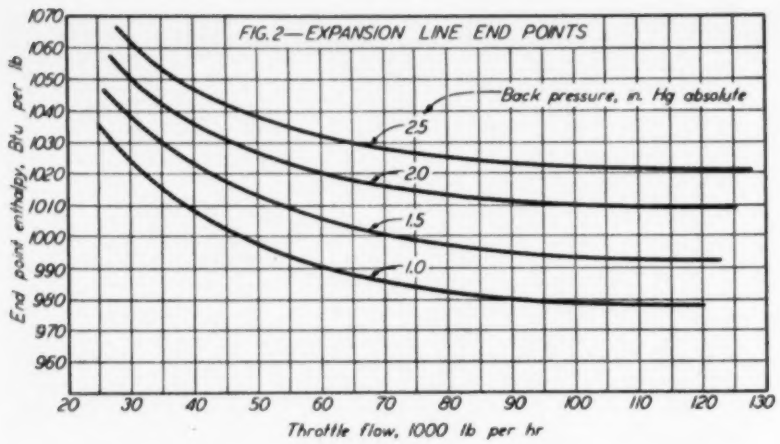
It should be noted that the calculation procedure is divided into two tables. This form is used to indicate the point at which information is required from a higher numbered line, since the formula for the extraction flow to No. 2 heater involves two unknowns; the combined drains from No. 3 heater, and the corresponding enthalpy value.

$$S = \frac{W\,(h_t - h_1) - W_2\,(h_2 - h_t)}{(H - h_t)}$$

This may be the stumbling block for the inexperienced. However, as outlined under (c) in the detailed notes on calculations of extraction flows, an estimate is made and the calculations continue based on the assumed data.

Now back to the procedure for No. 2 heater. The flow to the following stage at the second opening is equal to the flow to the following stage at the





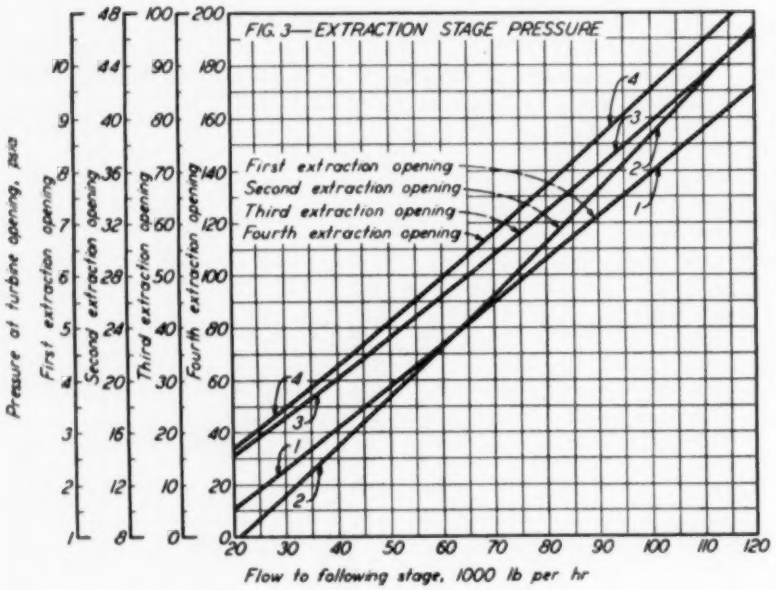


FIG. 3—EXTRACTION STAGE PRESSURE
First extraction opening
Second extraction opening
Third extraction opening
Fourth extraction opening
Pressure at turbine opening, psia
Flow to following stage, 1000 lb per hr

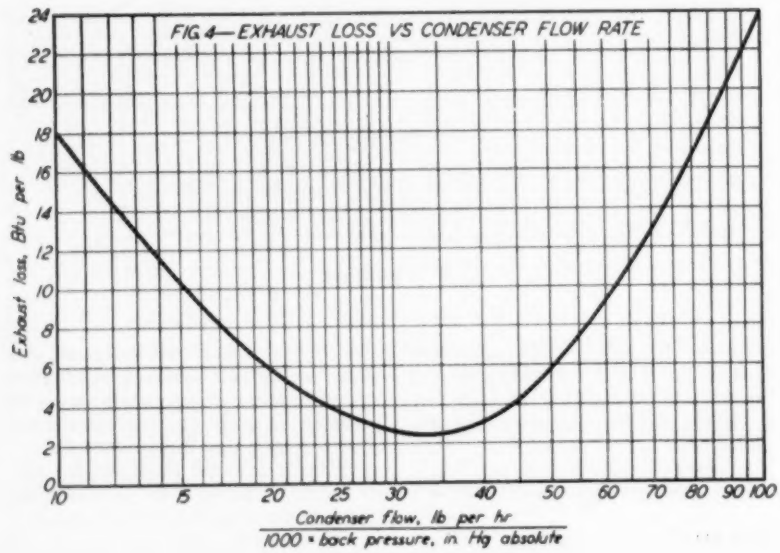


FIG. 4—EXHAUST LOSS VS CONDENSER FLOW RATE
Exhaust loss, Btu per lb
Condenser flow, lb per hr
1000 × back pressure, in. Hg absolute

first opening, plus the extraction flow at the first opening. These have already been established; so as described for the first heater, all data is available for solving the above equation except the two unknowns. The procedure is then written up to solve the equation.

No. 3 and No. 4 Heaters

Similar methods follow for determining extraction flows to both No. 3 and No. 4 heaters. The equations for these heaters are:

No. 3 . . .

$$S = \frac{W\,(h_f - h_1) - W_2\,(h_2 - h_a)}{(H - h_a)}$$

No. 4 . . .

$$S = \frac{W\,(h_f - h_1)}{(H - h_a)}$$

The procedure for each respective heater again is arranged so that the calculations solve these equations.

Both condenser flow and the throttle flow corresponding to this condenser flow are used in the calculations. These data may be found from methods given in the articles: "Calculation of Comparable Heat Rates of Steam Turbines," INDUSTRY AND POWER, Dec. 1952, and "Heat Rate Correction Factors for Steam Turbines with Varying Initial Pressure, Initial Temperature, or Back Pressure," INDUSTRY AND POWER, Jan. 1953. The combination of throttle flow and condenser flow found from these methods will not necessarily result in calculated outputs of exactly the desired value. If exact flows are required, the calculations can be repeated and the results interpolated.

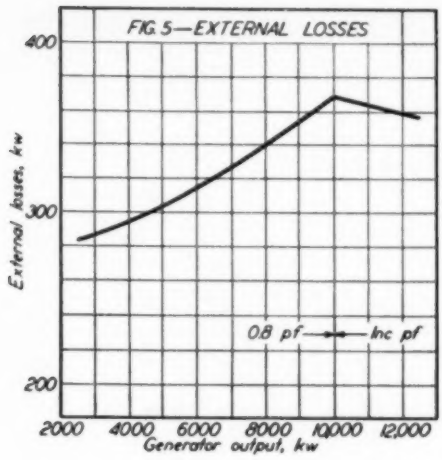
It should be noted that a method for including the heating of the feedwater by boiler feed pump work is detailed in the calculation procedure. Furthermore, there is an allowance for excess enthalpy, which is explained in the description of Fig. 7.

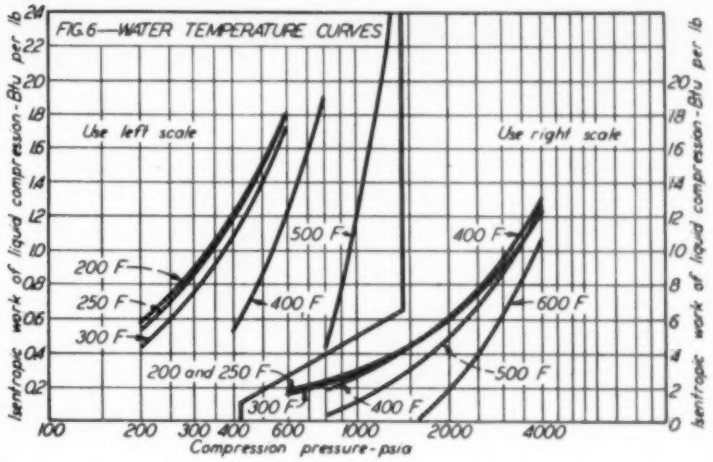
All of the calculations so far cover extraction flows to the respective heaters for the selected system arrangement. To supplement this information, an output calculation procedure is given which describes the steps required for figuring the output after the other data has been established.

Description of Illustrations

Fig. 1 shows expansion lines for specified throttle flows. For other throttle flows, the expansion line end point is obtained from the 1.5 in. Hg absolute back pressure curve on Fig. 2. This value is plotted at 1.5 in. Hg absolute on the expansion line, Fig. 1, and a curve is drawn through this point consistent with the adjacent curves.

While Fig. 1 is developed for the





design or base back pressure, it is used to read the enthalpy at an extraction point regardless of the back pressure at which calculations are made. When making calculations at other than the design back pressure and when it is desirable to draw in new throttle flow lines, the interpolation of these lines is always made and plotted at the design back pressure as noted above.

Expansion line end points at various back pressures are shown on Fig. 2. This curve has two uses: (a) for interpolating throttle flows, always at design back pressure (in this case 1.5 in. Hg abs), and (b) for determining the expansion line end point at the proper back pressure when calculating output.

Fig. 3 indicates the values of pressures at the turbine openings plotted against the flow to following stage.

The exhaust loss is shown on Fig. 4. This curve includes not only the losses in the exhaust hood (and the last stage leaving loss), but also the effect of the falling off of internal efficiency due to operation at other than the optimum conditions of exhaust flow and pressure. This loss must be added to the expansion line end point on Fig. 2 in order to obtain the correct value of final enthalpy when calculating output.

The external losses shown on Fig. 5 are the sum of the generator, exciter, and mechanical losses as well as end packing losses. They are the losses connected with the turbine and generator, but do not include boiler feed pump work.

Fig. 6 is the isentropic work of liquid compression and, when divided by the pump efficiency, gives the heat rise in the feedwater as it passes through the boiler feed pump.

An explanation of Fig. 7 is contained in the following quotation*. "When water at a given temperature is at a pressure higher than the vapor pressure corresponding to the temperature, its enthalpy is greater than the enthalpy of the saturated liquid by an amount which may be called the excess enthalpy. This excess over the enthalpy of saturated liquid at the same temperature is plotted on Fig. 7 against temperature, for various pressures. To obtain the enthalpy of water at any pressure and temperature; enter the curve at the temperature of the water, read from the proper pressure curve the excess of enthalpy over the saturation enthalpy, and add this value to the saturation enthalpy."

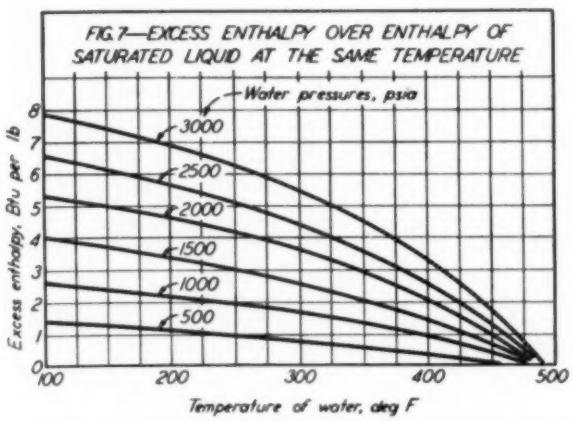
Fig. 8** shows the relationship between $(t - h_f)$ and saturation temperature or saturation enthalpy.

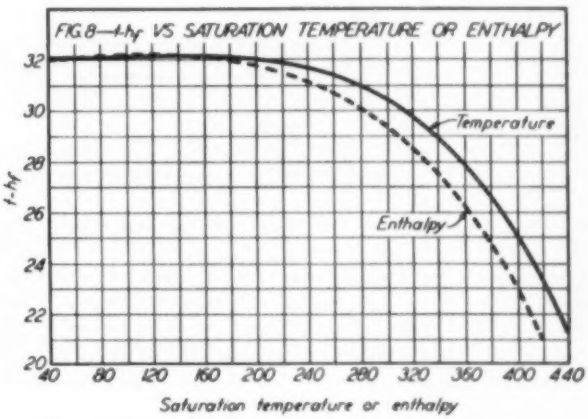
An estimate of boiler feed pump efficiency for use in the calculation is available on Fig. 9. While these values are approximate and may not be correct for all conditions, they serve to illustrate the use of this item.

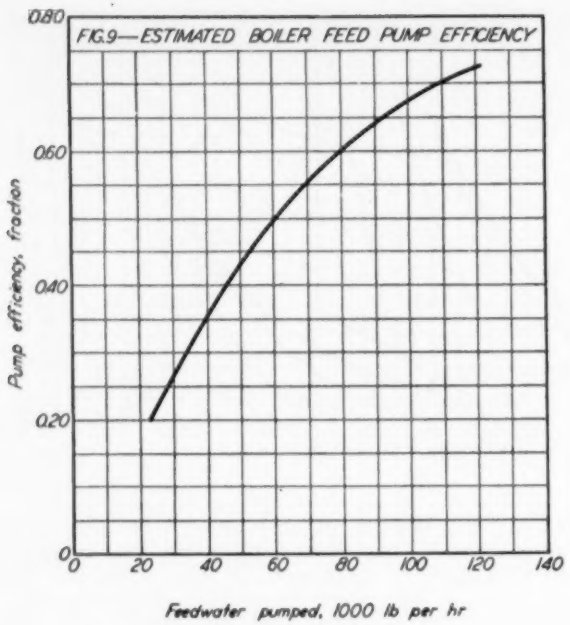
Fig. 10 shows the assumed variation of terminal temperature difference. It is plotted against quantity of feedwater entering the heater which is a known value at the time the terminal

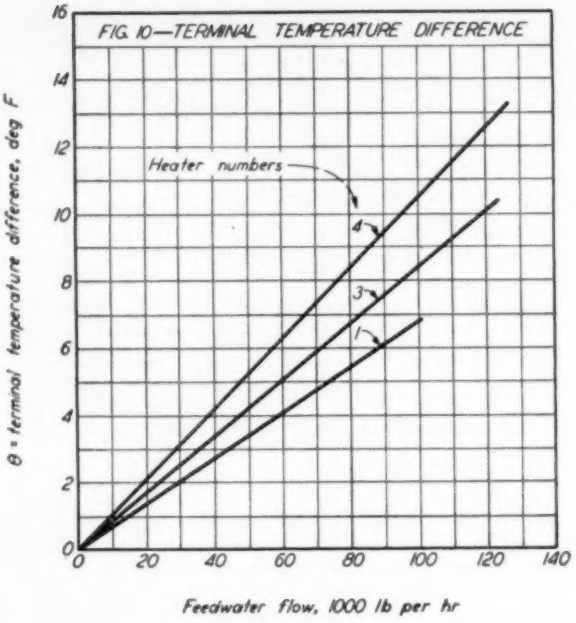
* Fig. 7 and its related description have been reproduced by permission from "Steam Turbines and Their Cycles" by J. Kenneth Salisbury, John Wiley and Sons, New York, 1950.

** Fig. 8 has been plotted from data taken by permission from "The Thermodynamic Properties of Steam" by Keenan and Keyes, John Wiley and Sons, New York, 1936.









temperature difference is selected. The straight line variation is the usual accepted characteristic. In some cases, calculations are made with a constant terminal temperature difference. Some margin is incorporated in the calculation by this assumption.

Many engineers will find that this method of attacking the feedwater heating calculation problem and the sample numerical examples are very valuable references especially when such calculations are required only at occasional intervals rather than as a steady diet. The method at first glance seems to be long and cumbersome. However, a careful study will indicate that the mystery disappears as the calculations progress, and the final result is obtained promptly. The advantages and time saving features of this type of feedwater heating calculation will become more apparent when extensive use is made of these methods.

CALCULATION PROCEDURE FOR DETERMINING EXTRACTION FLOWS

Note: Example is for a 10,000 kw, 60 cycle turbine-generator designed for 600 psig, 825 F TT steam and 1.5 in. Hg absolute back pressure

Line	Symbol	Source	Description	Numerical values				
			No. 1 Heater					
0		Given	Load, kw	12,500	10,000	7500	5000	2500
1	F_T	Estimate	Throttle flow, lb per hr	120,700	95,200	71,400	48,900	27,700
101	W_o	Estimate	Steam flow to stage following extraction opening, lb per hr	90,900	73,000	56,120	39,560	23,460
102		At 101	Pressure at turbine, psia	7.22	5.74	4.36	3.06	1.81
105	H	At 1 and 102	Enthalpy of steam at turbine, Btu per lb	1098	1088	1080	1076.5	1080
106		5% of 102	Pressure drop to heater, psi	0.36	0.29	0.22	0.15	0.09
107		102 — 106	Pressure of steam in heater, psia	6.86	5.45	4.14	2.91	1.72
108	t	At 107	Saturation temperature of steam in heater, deg F	176.0	166.0	154.4	140.3	120.6
109	θ	Fig. 10 at 101	Terminal temperature difference, deg F	(a) 6.2	(f) 5	3.8	2.7	1.6
110	t	108 — 109	Temperature of water leaving heater, deg F	169.8	161.0	150.6	137.6	119.0
111		Fig. 8 at 110	t — h_Z	32.1	32.1	32.1	32.1	32.1
112	h_Z	110 — 111	Enthalpy of feedwater leaving heater, Btu per lb	137.7	128.9	118.5	105.5	86.9
113	h_1	At back pressure	Enthalpy of liquid at condenser hotwell, Btu per lb	59.7	59.7	59.7	59.7	59.7
114		112 — 113	Enthalpy rise of feedwater in heater, Btu per lb	78.0	69.2	58.8	45.8	27.2
115	h_e	At 107	Enthalpy of condensate in heater, Btu per lb	143.9	133.8	122.3	108.1	88.5
116		105 — 115	H — h_e	954.1	954.2	957.7	968.4	991.5
117		101 × 114	W_o (h_Z — h_1)	7,090,200	5,051,600	3,299,856	1,811,848	638,112
118		116 — 114	(H — h_e) — (h_Z — h_1)	876.1	885.0	898.9	922.6	964.3
119	S	117/118	Steam extraction to heater, lb per hr	8093	5708	3671	1964	662
120		101 + 119	Total feedwater leaving heater, lb per hr	98,993	78,708	59,791	41,524	24,122
			No. 2 Heater					
200		120	Feedwater entering heater, lb per hr	98,993	78,708	59,791	41,524	24,122
201		101 + 119	Steam flow to stage following extraction opening, lb per hr	98,993	78,708	59,791	41,524	24,122
202		At 201	Pressure at turbine, psia	38.3	30.0	22.5	(a)	(a)
205	H	At 1 and 202	Enthalpy of steam at turbine, Btu per lb	1196.5	1183	1171.5	(b) 1208	(b) 1205.5
206		5% of 202	Pressure drop to heater, psi	1.9	1.5	1.1		
207		202 — 206	Pressure of steam in heater, psia	36.4	28.5	21.4	16.7	16.7
208	h_Z	At 207	Enthalpy of condensate in heater, Btu per lb	230.4	215.8	199.8	186.6	186.6
209	h_1	112	Enthalpy of feedwater entering heater, Btu per lb	137.7	128.9	118.5	105.5	86.9
210		208 — 209	Enthalpy rise in heater, Btu per lb	92.7	86.9	81.3	81.1	99.7

Small letters in parentheses refer to the detailed notes on calculation procedures.

CALCULATION PROCEDURE FOR DETERMINING EXTRACTION-FLOWS

Note: Example is for a 10,000 kw, 60 cycle turbine-generator designed for 600 psig, 825 F TT steam and 1.5 in. Hg absolute back pressure

Line	Symbol	Source	Description	Numerical values																
			No. 2 Heater																	
0		Given	Approximate load, kw	12,500	12,500	12,500	10,000	10,000	10,000	7500	7500	7500	5000	5000	5000	2500	2500	2500		
211	W_2	327	Drain from No. 3 heater, lb per hr	(c)	(i) 12,200	12,092	(c)	(i) 9165	9144	(c)	(i) 6520	6436	(c)	(i) 3790	3634	(c)	(r) 1100	1099		
212	h_2	320	Enthalpy of drain from No. 3 heater, Btu per lb	(c)	(i) 283.3	283.6	(c)	(i) 265.7	265.8	(c)	246.4		(c)	(i) 218.9		(c)	(s) 238.2	238.5		
213		212 − 208	$h_0 - h_f$	(c)	52.9	53.2	(c)	49.9	50.0	(c)	46.6		(c)	32.3		(c)	51.6	51.9		
214		200 × 210	W $(h_f - h_1)$	9,170,000	9,176,651	9,176,651	6,840,000	6,839,725	6,839,725	4,860,000	4,861,008	4,861,008	3,367,000	3,367,596	3,367,596	2,405,000	2,404,963	2,404,963		
215		211 × 213	$W_2 (h_0 - h_f)$	(c)	645,380	643,241	(c)	457,334	457,200	(c)	303,832	299,918	(c)	122,417	117,378	(c)	56,760	57,038		
216		214 − 215	W $(h_f - h_1) - W_2 (h_0 - h_f)$	(c)	8,531,271	8,533,410	(c)	6,382,391	6,381,525	(c)	4,557,176	4,561,090	(c)	3,245,179	3,250,218	(c)	2,348,203	2,347,925		
217		205 − 208	$H - h_f$	966.1			967.2			971.7			1021.4			1018.9				
218	S	216/217	Steam extraction to heater, lb per hr	(d) 8500	8831	(j) 8833	(d) 6370	6599	(j) 6598	(d) 4650	4690	(j) 4694	(d) 3100	3177	(i) 3182	(d) 2200	2304	(j) 2304		
219		200 + 211 + 218	Total feedwater leaving heater, lb per hr	(e) 120,700	120,024		(e)	94,472	94,450	(e) 71,400	71,001		(e) 48,900	48,491	48,340	(e) 27,700	27,526	27,525		
			Boiler Feed Pump																	
P1		219	Feedwater pumped, lb per hr	(e) 120,700	120,024	119,917	(e) 95,200	94,472	94,450	(e) 71,400	71,001	70,921	(e) 48,900	48,491		(e) 27,700				
P2		Given	Pressure of feedwater leaving boiler feed pump, psia	768			768			768			768			768				
P3		Fig. 6	Isentropic work of liquid compression, Btu per lb	2.3			2.3			2.3			2.3			2.3				
P4		At P1 and Fig. 9	Boiler feed pump efficiency, fraction	0.728			0.66			0.557			0.423			0.245				
P5		P3/P4	Enthalpy increase of feedwater, Btu per lb	3.2			3.5			4.1			5.4			9.4				
P6		208 + P5	Enthalpy of feedwater entering next heater, Btu per lb	233.6			219.3			203.9			192.0			196.0				
			No. 3 Heater																	
300		P1	Feedwater entering heater, lb per hr	(e) 120,700	120,024	119,917	(e) 95,200	94,472	94,450	(e) 71,400	71,001	70,921	(e) 48,900	48,491	48,340	(e) 27,700				
301		201 + 218	Steam flow to stage following extraction opening, lb per hr	107,493	107,824	107,826	85,078	85,307	85,306	64,441	64,481	64,485	(n) 41,524			(n) 24,122				
302		At 301	Pressure at turbine, psia	85.8	86.1	(k) 86.1	66.7	66.8	(k) 66.8	49.7	(k) 49.7		31.7			18.6				
305	H	At 1 and 302	Enthalpy of steam at turbine, Btu per lb	1254	1254.5		1238	1238		1225			1208			1205.5				
306		5% of 302	Pressure drop to heater, psi	4.3	4.3		3.3	3.3		2.5			1.6			0.9				
307		302 − 306	Pressure of steam in heater, psia	81.5	81.8		63.4	63.5		47.1			30.1			17.7				
308	t	At 307	Saturation temperature of steam in heater, deg F	313.4	313.6		296.4	296.5		277.4			250.6			221.7				
309	#	Fig. 10 at 300	Terminal temperature difference, deg F	(f) 10.1	10.1		(f) 8	8		6.0			4.1			2.3				
310	t	308 − 309	Temperature of water leaving heater, deg F	303.3	303.5		288.4	288.5		271.4			246.5			219.4				
311		Fig. 8 at 310	t − h_f	30.3	30.3		30.7	30.7		31.1			31.6			31.9				
312		310 − 311	Enthalpy of saturated liquid, Btu per lb	273.0	273.2		257.7	257.8		240.3			214.9			187.5				
313		P2	Pressure of feedwater, psia	768			768	768		768			768			768				
314		Fig. 7 at 310 and 313	Excess enthalpy, Btu per lb	1.2	1.2		1.3	1.3		1.4			1.5			1.6				
315	h_f	312 + 314	Enthalpy of feedwater leaving heater, Btu per lb	274.2	274.4		259.0	259.1		241.7			216.4			189.1				
316	h_1	P6	Enthalpy of feedwater entering heater, Btu per lb	233.6	233.6		219.3	219.3		203.9			192.0			196.0				
317		315 − 316	Enthalpy rise of feedwater in heater, Btu per lb	40.6	40.8		39.7	39.8		37.8			24.4			(q) -6.9				
318	W_3	420	Drain from No. 4 heater, lb per hr	(c)	(i) 7680	7552	(c)	(i) 5665	5630	(c)	(i) 3950	3921		(i) 2620	2594					
319	h_3	418	Enthalpy of drain from No. 4 heater, Btu per lb	(c)	(i) 348	348.3	(c)	(i) 326.5	326.7	(c)	(i) 302.8	302.8	(c)	(i) 274.0			238.2				
320	h_0	At 307	Enthalpy of condensate in heater, Btu per lb	283.3	283.6	283.6		265.8	265.8	246.4	246.4		218.9	218.9			189.6			
321		319 − 320	$h_0 - h_f$	(c)	64.4	64.7	(c)	60.7	60.9	(c)	56.4	56.4	(c)	55.1						
322		308 × 317	W $(h_f - h_1)$	4,900,000	4,896,979	4,892,614	3,780,000	3,760,000	3,759,110	2,700,000	2,683,838	2,680,814	1,194,000	1,183,180	1,179,496					
323		318 × 321	$W_3 (h_0 - h_f)$	(c)	489,440	488,614	(c)	343,866	342,867	(c)	222,780	221,144	(c)	144,362	142,294					
324		322 − 323	W $(h_f - h_1) - W_3 (h_0 - h_f)$	(c)	4,407,539	4,404,000	(c)	3,416,214	3,416,243	(c)	2,461,058	2,459,670	(c)	1,038,818	1,037,202					
325		305 − 320	$H - h_f$	970.7	970.9		972.3	972.2		978.6			989.1							
326	S	324/325	Steam extraction to heater, lb per hr	(g) 4600	4540	(j) 4536	(g) 3500	3514	(j) 3514	(g) 2570	2515	2513	(g) 1170	1060	(j) 1049	(q) 0				
327		318 + 326	Total drain from heater, lb per hr	(h)	12,140	12,088	(h)	9179		(h)	6465	(j) 6434	(h)							
			No. 4 Heater																	
400	W	219	Feedwater entering heater, lb per hr	(e) 120,700	(m) 119,964	(m) 119,914	(e) 95,200	(m) 94,486	(m) 94,450	(e) 71,400	(m) 70,946	(m) 70,919	(e) 48,900	(m) 48,371	(m) 48,349	27,700	27,526	27,525		
401		301 + 326	Steam flow to stage following extraction opening, lb per hr	112,093	112,364	112,362	88,578	88,821	88,821	67,011	66,996	66,998	(p) 45,794	45,751	45,755	(p) 26,322	26,426	26,426		
402		At 401	Pressure at turbine, psia	193.7	194.1	(k) 194.1	150.0	150.4	(k) 150.4	111.4	(k) 111.4		75.2			43.6	43.8			
405	H	At 1 and 402	Enthalpy of steam at turbine, Btu per lb	1322	1322		1303.0	1303.5		1287			1273.5			1265	1265			
406		5% of 402	Pressure drop to heater, psi	9.7	9.7		7.5	7.5		5.6			3.8			2.2	2.2			
407		402 − 406	Pressure of steam in heater, psia	184.0	184.4		142.5	142.9		105.8			71.4			41.4	41.6			
408	t	At 407	Saturation temperature of steam in heater, deg F	375	375.2		354.7	354.9		332.0			304.3			269.4	269.7			
409	#	Fig. 10 at 400	Terminal temperature difference, deg F	12.7	12.7		10	10		7.5			5.2			2.9	2.9			
410	t	408 − 409	Temperature of feedwater leaving heater, deg F	362.3	362.5		344.7	344.9		324.5			299.1			266.5	266.8			
411		Fig. 8 at 410	t − h_f	27.7	27.7		28.6	28.6		29.5			30.4			31.2	31.2			
412		410 − 411	Enthalpy of saturated liquid, Btu per lb	334.6	334.8		316.1	316.3		295.0			268.7			235.3	235.6			
413		P2	Pressure of feedwater, psia	768			768			768			768			768				
414		Fig. 7 at 410 and 413	Excess enthalpy, Btu per lb	0.9	0.9		1.0	1.0		1.1			1.3			1.4	1.4			
415	h_f	412 + 414	Enthalpy of feedwater leaving heater, Btu per lb	335.5	335.7		317.1	317.3		296.1			270.0			236.7	237.0			
416	h_1	315	Enthalpy of feedwater entering heater, Btu per lb	274.2	274.4		259.0	259.1		241.7			216.4			(s) 196.0	196.0			
417		415 − 416	Enthalpy rise of feedwater in heater, Btu per lb	61.3	61.3		58.1	58.2		54.4			53.6			40.7	41.0			
418	h_0	At 407	Enthalpy of condensate in heater, Btu per lb	348.0	348.3		326.5	326.7		302.0			274.0			238.2	238.5			
419		405 − 418	$H - h_0$	974	973.7		976.5	976.8		984.2			999.5			1026.8	1026.5			
420	S	400 × 417/419	Steam extraction to heater, lb per hr	7600	7552	(j) 7549	5665	5630	(j) 5628	3950	3921	(j) 3920	2620	2594	(j) 2593	1100	1099	(j) 1099		
421	Fr	201 + 218 + 326 + 420	Throttle flow, lb per hr			119,911			94,448			70,918			48,348			27,525		

Small letters in parentheses refer to the detailed notes on calculation procedure.

CALCULATION PROCEDURE FOR DETERMINING OUTPUT AND NET HEAT RATE

Note: Example is for a 10,000 kw, 60 cycle turbine-generator designed for 600 psig, 825 F TT steam and 1.5 in. Hg absolute back pressure

Line	Symbol	Source	Description	Numerical values				
0		Given	Approximate load, kw	12,500	10,000	7500	5000	2500
1	F_T	421	Throttle flow, lb per hr	119,911	94,448	70,918	48,348	27,525
2	F_c	101	Condenser flow, lb per hr	90,900	73,000	56,120	39,540	23,460
3		2/1000 × BP	BP = back pressure, in. Hg abs	60.6	48.7	37.4	26.4	15.6
4		Fig. 4 at 3	Exhaust loss, Btu per lb	9.5	5.3	2.7	3.3	9.6
5		Fig. 2 at 1	Expansion line end point, Btu per lb	992.3	994.0	999.8	1014.0	1042.5
6	H_0	At 600 psig, 825 F TT	Initial enthalpy, Btu per lb	1420.9	1420.9	1420.9	1420.9	1420.9
7		4 + 5	Actual final enthalpy, Btu per lb	1001.8	999.3	1002.5	1017.3	1052.1
8		6 − 7	Over-all used energy, Btu per lb	419.1	421.6	418.4	403.6	368.8
9	H_1	105	No. 1 point enthalpy, Btu per lb	1098	1088	1080	1076.5	1080
10		6 − 9	No. 1 point used energy, Btu per lb	322.9	332.9	340.9	344.4	340.9
11	S_1	119	No. 1 point extraction flow, lb per hr	8093	5708	3671	1964	662
12	H_2	205	No. 2 point enthalpy, Btu per lb	1196.5	1183	1171.5	(a)	(a)
13		6 − 12	No. 2 point used energy, Btu per lb	224.4	237.9	249.4		
14	S_2	218	No. 2 point extraction flow, lb per hr	8833	6598	4694	0	0
15	H_3	305	No. 3 point enthalpy, Btu per lb	1254.5	1238	1225	1208	1205.5
16		6 − 15	No. 3 point used energy, Btu per lb	166.4	182.9	195.9	212.9	215.4
17	S_3	326	No. 3 point extraction flow, lb per hr	4536	3514	2513	(t) 4231	(t) 2304
18	H_4	405	No. 4 point enthalpy, Btu per lb	1322	1303.5	1287	1273.5	1265
19		6 − 18	No. 4 point used energy, Btu per lb	98.9	117.4	133.9	147.4	155.9
20	S_4	420	No. 4 point extraction flow, lb per hr	7549	5628	3920	2593	1099
21		2 × 8/3413	Over-all output, Wkw	11,162	9017	6880	4678	2535
22		11 × 10/3413	No. 1 point output, Wkw	766	557	367	198	66
23		14 × 13/3413	No. 2 point output, Wkw	581	460	343	0	0
24		17 × 16/3413	No. 3 point output, Wkw	221	188	144	264	145
25		20 × 19/3413	No. 4 point output, Wkw	219	194	154	112	50
26		21 + 22 + 23 + 24 + 25	Total output, Wkw	12,949	10,416	7888	5252	2796
27		Fig. 5 at 26	Mechanical and generator losses, kw	356	368	334	302	283
28		26 − 27	Generator output, Ekw	12,593	10,048	7554	4950	2512
29		P5	Enthalpy increase of feedwater, Btu per lb	3.2	3.5	4.1	5.4	9.4
30		Given	Efficiency of driver, fraction	0.92	0.92	0.915	0.91	0.905
31		1 × 29/30 × 3413	Power consumed by boiler feed pump, kw	122	105	93	84	85
32	kw	28 − 31	Net output, kw	12,471	9943	7461	4866	2427
33		415	Final enthalpy of feedwater, Btu per lb	335.7	317.3	296.1	270.0	237
34		6 − 33	Heat added in boiler, Btu per lb	1085.2	1103.6	1124.8	1150.9	1183.9
35	HR	1 × 34/32	Net heat rate, Btu per kwh	10,434	10,483	10,691	11,435	13,426

With more than four extraction points, additional lines similar to **18** to **20** inclusive may be added. Also add line or lines similar to **25** before determining total output.

In case the boiler feed pump is turbine driven, use a value of 1.0 for line **30** and add the steam flow to this turbine to the throttle flow when calculating the heat rate. The exhaust from the boiler feed pump turbine will be included in the heat balance.

When calculating line 31, if feedwater flow is not the same as throttle flow, use feedwater flow instead of line 1 in the formula.

Small letters in parentheses refer to the detailed notes on calculation procedures.

NOTES ON CALCULATION PROCEDURE

Make 4/4 load calculation first. Some items, such as terminal temperature difference, may depend on value at 4/4 load flow.

(a) Do not plot Fig. 10 until 4/4 load flows have been determined. Only one column of figures per load is required as long as the data is known or is taken from a previous line. When data for a line involves a higher numbered line, an estimate must be made using cut and try methods. By recording each estimate in adjacent columns, the final estimate is simplified as the results of previous estimates appear in the previous columns. These methods will be explained in detail as required.

(a) The assumed feedwater heating cycle and related calculations do not include any heating steam supply. If steam for heating were required, supply would be from No. 3 extraction opening with heater pressure held at a minimum value by reducing valve because pressure at No. 2 extraction opening is too low for normal deaerator operation.

(b) Enthalpy at No. 3 extraction opening.

(c) Now the cut and try methods start as data from a higher numbered line are required, and these data have not been calculated. Don't waste time trying to be too precise. For the first trial, skip all lines with notation (c). For the second and subsequent trials, read data for the higher numbered lines from the immediately previous trial. The trials are continued until the calculated value of the higher numbered lines agree closely with the calculated value of the previous trial, or until further refinement does not change resultant values.

(d) For first trial, find a rough value of S, line 218, by dividing line 214 by line 217, and reducing the result by about 10 per cent. The magnitude of this reduction of 10 per cent more or less is not too critical. As the calculations progress, it will be apparent that the closer the estimated value of S is to the actual value of S, the fewer the number of trials that will be required to obtain a balance.

(e) For first trial, assume line 219 equals line 1.

(f) Use 4/4 load design value when making 4/4 load calculations.

(g) For first trial, find a rough value of S, line 326, by dividing line 322 by line 325 and reducing the result by about 10 per cent. See comments under note (d).

(h) Omit for first trial.

(i) As mentioned under note (c), read values from previous trial.

(j) A comparison of these figures with those of the previous trial shows that further trials are not required.

(k) The pressure for this trial is the same as for the previous trial. Therefore, a number of subsequent items are the same as in the previous trial.

(m) Revise value of line 219 used at this point to include value of line 327 which has just been found. Add lines 327 and 301.

(n) Line 301 is the same as line 201 as there is no extraction from the second opening.

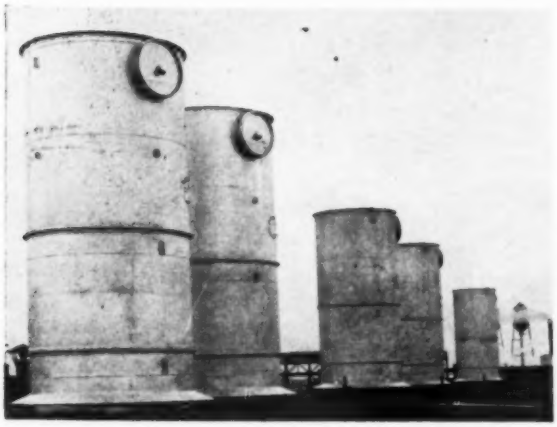
(p) Since third extraction opening supplies steam to both second and third heaters, line 401 equals lines 301 + 218 + 326.

(q) A negative rise at line 317 indicates no heating in this heater.

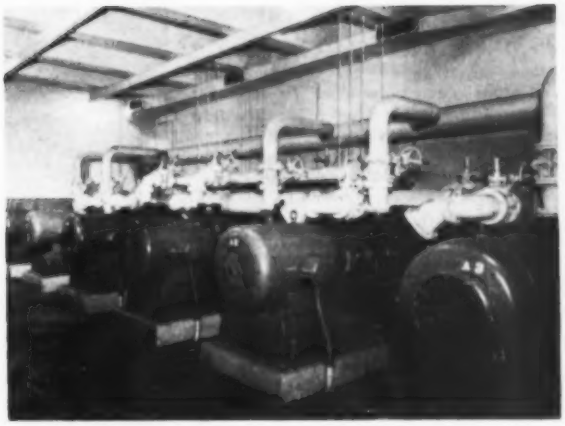
(r) Since the third heater cannot absorb any heat, assume that some of fourth heater condensate flashes into steam in the third heater and that this steam mixes with the third opening steam going to the second heater. This flashed steam replaces some steam coming from the third extraction opening. For convenience, however, use line 420 in line 211 and line 418 in line 212. This accounts for the heat in the fourth heater condensate and its use at this point will result in the proper extraction flow to the heater, line 218.

(s) With no heating in the third heater, the enthalpy of the feedwater entering the fourth heater is the same as line P6.

(t) Sum of lines 218 and 326, total extraction from third opening to second and third heaters respectively.



Five of the 36 water spray type dust collectors that have been erected at the Buick plant to remove foundry dust.



Seven centrifugal pumps, driven with 75-hp motors, draw water from settling tanks and discharge it to collectors.

Buick Washes Away Waste Problem

HERBERT CHASE
Mechanical Engineer

BUICK MOTOR DIVISION, General Motors Corporation, is making rapid strides in modernizing their gray iron foundry, a highly important unit of the Division's huge Flint, Mich. plant. Alterations and extensions of the foundry have proceeded for many months without interruption of production.

Foundry modernization includes a huge system for removing dust and washing it into sludge tanks at the rate of five carloads a day. Water in the tanks is cleaned by settling and then recirculated.

Numerous dust collectors have been used in the foundry for many years, but the number has been constantly increased until it has reached a total of 36 either in use or in process of erection. Several of the new collectors are in the new cleaning room of the recently built foundry now being used temporarily for defense production work.

Spray Type Collector

All collectors are the *multi-wash* type that remove the dust by passing it through water sprays and curtains. Most of the collectors have a capacity of 36,000 cfm. They are designed with 6½ wet, impingement stages, a wet cyclone in a conical base, and a water separator in the top compartment.

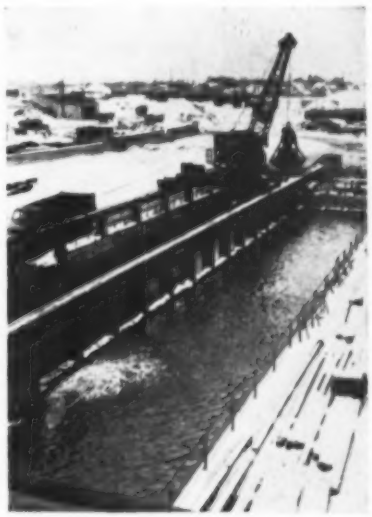
Air drawn from the foundry is forced tangentially into the bottom cyclone. Here the coarse particles are thrown out by centrifugal force. The air then passes upward in a swirling motion, which is caused by baffles. Stages consist of curtains, sprays, and wetted surfaces upon which the dust is collected. This surface is constantly being washed, and the dust is finally discharged to the sludge outlet at the base of the cone.

Water is fed to each collector at the center of the baffle below the entrainment separator at the rate of 110 gpm. Flow is downward over the lower vanes and baffles. Sludge feeds into 12 in. pipes that empty into one of two settling tanks provided for this purpose. Each of these tanks has a capacity of 100,000 gal. These tanks were doubled in size to care for the added collectors. Tanks are poured concrete, 22 ft wide, 150 ft long, and 13 ft deep. A track has been installed above each tank to accommodate a crane equipped with a clamshell to remove the sludge.

Pumping System

When the system was increased, an entirely new pumping system was installed in a concrete vault below the settling tanks. Water feeds by gravity to the pumps from a point about 4 ft below high level in the tank. The pumps circulate the water into the lines that feed the dust collectors. In the pumping system, there are 7 centrifugal pumps, which have a capacity of 1200 gpm. Each unit is directly driven by a 75 hp motor turning at 900 rpm.

As in most large foundries, there are numerous areas in which dust is produced. However, at Buick, suction fans draw off the dust supply so rapidly and effectively that this foundry is one of the cleanest of its size and type to be found. The air cleaning system is possibly the largest in the foundry industry and plays a great part in providing excellent working conditions in the buildings served by the system.



One of two settling tanks that receives the wash water from the collectors. The sludge is removed by means of the crane at the rate of five carloads per day.

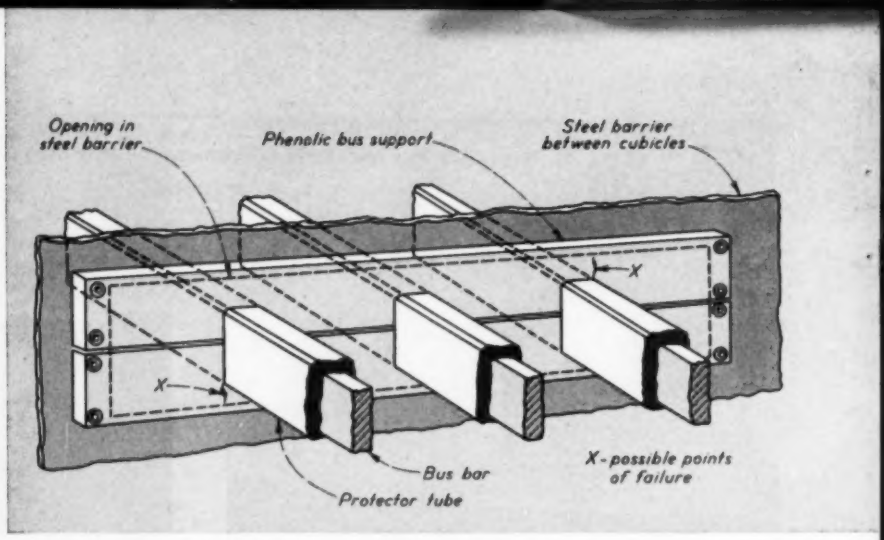


Fig. 1—Metalclad switchgear may fail when excessive amounts of dust, salt or other chemicals exist in the air. For example, protector tubes are not designed for full voltage from bus to steel barrier (ground). If phenolic bus supports become covered with contaminants, electrostatic discharge may cause tracking as at X, carbonizing and other deterioration of insulating value. Eventually, ground potential is applied to outside surface of the protector tube at the support, greatly increasing probability of fault at that point. Where the possibilty of such trouble in high voltage switchgear exists, preventive measures such as suggested in the text should be considered.

Using Metalclad Switchgear In Contaminated Areas

FRANK E. REEVES
Electrical Engineer

THERE HAS BEEN a growing tendency in the past several years to assume that metalclad switchgear for use up to 13,800 v is the answer to all hazards which might cause accidental shutdowns. Placing buses and other live parts in steel enclosures, with segregation of individual cubicles and vulnerable components, is frequently believed to be almost positive insurance against spreading of arcing and burning. It is reasoned that breakdown in one section will be adequately contained and cleared, and therefore the remainder of the equipment will continue to operate satisfactorily.

All of the above is true under ideal conditions. The fact that conditions are not always ideal should suggest caution in the selection of the proper equipment for particular applications.

Although such switchgear is apparently completely enclosed, it cannot be hermetically sealed due to the need for dissipating the heat caused by the inevitable electrical losses. Much of the heat radiates from the exposed external steel surfaces of the enclosures. However, when large amounts of power are being handled, this radiation is inadequate. Some heat must therefore be dissipated by air circulating through various openings.

Most types of metalclad switchgear depend on air leakage through joints (intentionally ungasketed for this reason) in the steel plates. In the very heavy duty types, openings are provided for intake of air in the lower sections, with vents in the upper sections. In any case, cool air enters the bottom and leaves through the upper cracks or vents. The warmer the buses and other components become, the faster air circulates, making the cooling scheme responsive to load change.

If air which enters the compartments is contaminated by salt, chemical fumes, or dust, there is a danger that the contaminants will deposit at critical points and cause trouble. Particles have been found to accumulate on or near the live buses, terminals, and bushings at a greater rate than on other parts. This is due to electrostatic action or to the usually higher temperatures of the live parts.

Unfortunately, the location at which

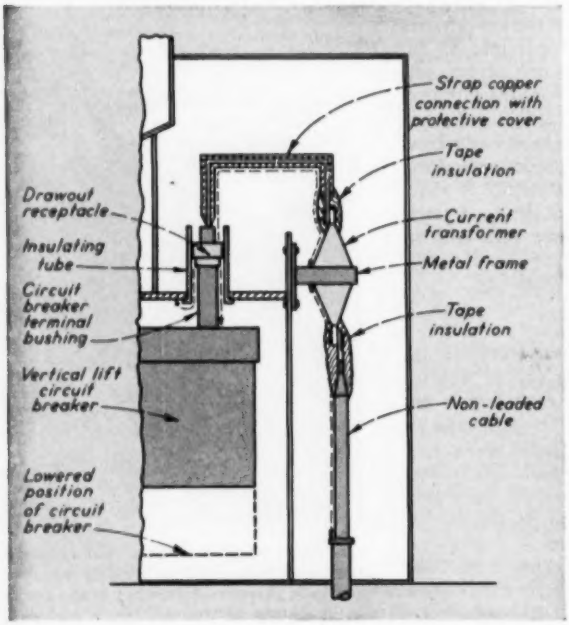


Fig. 2—This view illustrates the creepage paths, shown by dotted arrows, in a rear section typical of most metalclad switchgear. The drawout plug and receptacle of the circuit breaker represent worst condition in contaminated atmospheres because they cannot be fully insulated. Other live parts may be protected by taping. Creepage paths are long and unlikely to cause trouble unless contaminants attack the cable insulation or tape.

the deposit can prove most disastrous is that at which it most frequently occurs, namely, on the buses. Several failures have occurred from breakdown of bus insulation caused by contaminated atmospheres. Where switchgear is located near sea water, or in chemical plants or other industrial plants where the air contains salt or chemical fumes or dust, trouble may be expected.

Solids carried in the air will deposit on the phenolic or other forms of insulating boards which support the buses as they pass from one cubicle to the next, Fig. 1. After these contaminants deposit on the insulation, moisture from the air may be absorbed by them, particularly if they contain sodium, potassium, or similar chemicals having an affinity for water. A relatively low resistance path to ground and between conductors is created.

The protector tubes consist of molded phenolic or other types of insulation which may be molded on or slipped over the buses. Usually, and particularly at the higher voltages, these tubes will not withstand the operating voltage to ground or between conductors. They are not intended to provide full insulation in themselves, since, under normal conditions, they are not required to do so.

Some corona may be present if the operating voltage is in the higher range up to 13,800 v. In any case, electrostatic discharges will occur over the surfaces of the phenolic insulating boards if contaminants have been deposited on them. These discharges cause tracking and pitting of the surfaces of the bus supports, Fig. 1. After this has taken place, ground potential, or the potential of the adjacent phase, appears on the outer surfaces of the protector tubes and a fault may occur on the bus.

Although failure may be avoided or postponed by frequent cleaning of the insulating boards supporting the buses, this usually requires shutting down that part of the generating capacity feeding the particular section, and possibly the corresponding feeders. Under the circumstances, porcelain bushings, potheads, and insulators should also be cleaned, but they are less susceptible to tracking, and therefore need not be cleaned as frequently.

Where the condition of contaminated atmosphere is recognized before the switchgear is purchased, metalclad switchgear may be used, provided the gear is installed in a room which may be readily air conditioned. In such cases, scrubbing the air also may be necessary. Otherwise, non-enclosed equipment and buses should probably be used, with provision for frequent cleaning.

When switchgear is already in place, air conditioning of the room in which the switchgear exists is sometimes the only practical solution.

Re-insulating of the buses may be possible, but this is usually a difficult and probably impractical solution. Relocation of buses outside the switchgear is possible, but offers many obstacles.

Where the air is contaminated, a room in which switchgear is located may be placed under slight pressure with air drawn from the pure source. Leakage then always will be from the inside to the outside. This is frequently done in hazardous locations where the atmosphere is explosive. The air is usually drawn from a high stack.

That manufacturers recognize and are working to alleviate the problems is evidenced by recent revisions and additions to the NEMA Standards for Power Switchgear Assemblies, publication No. SG5-1950. These are dated October 8, 1952, and are identified as "Approved Standards, SG4S, pages 31 to 37, inclusive".

Under "Unusual Service Conditions", it states that for ambients over 40 C that the manufacturer's recommendations should be obtained. It also states that, "wherever possible, steps should be taken at the site of the installation to nullify the deleterious effects of unusual service conditions so that standard switchgear assemblies can be installed." Then 17 types of unusual conditions are listed.

Five expedients are given for mitigating effects of unusual conditions in order that standard assemblies may be used. These include shielding against entrance of steam, moisture, and the like, locating equipment remote from the sources of contamination, air conditioning and filtering the air in an enclosing room, providing an adequate scheduled maintenance program, and maintaining an adequate supply of spare parts replacements. Special treatments of components of switchgear exposed to unusual conditions are also listed. However, no attempt is made to specify limits of contamination or humidity, and manufacturers should be consulted when doubt exists.

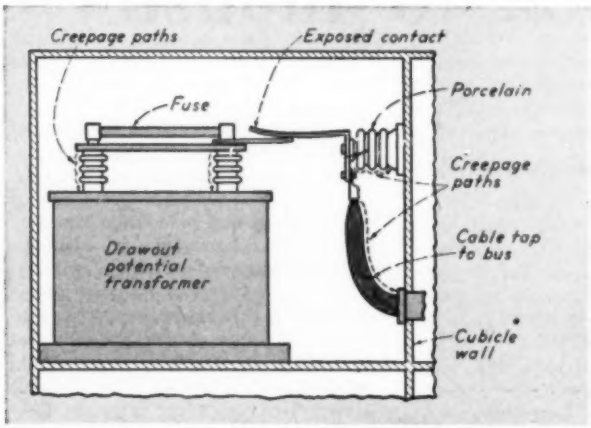


Fig. 3—The drawout potential transformer compartment is a very vulnerable spot in metalclad switchgear. Insulation is usually adequate, but where atmosphere is contaminated trouble may be expected here. High voltage contacts cannot be fully insulated, resulting in four creepage paths to ground. The worst may be on the insulation of the cable tap to ground, where contaminants may deposit and cause a flashover or may deteriorate the insulation causing failure

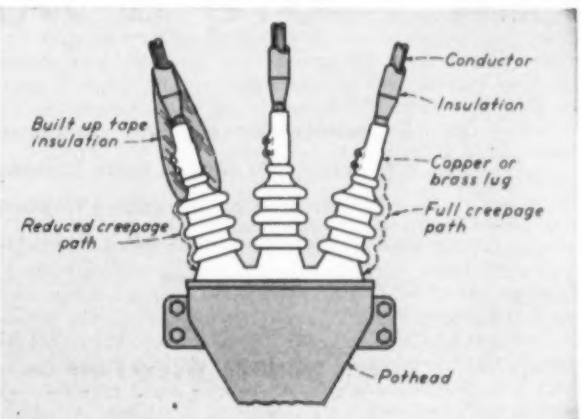
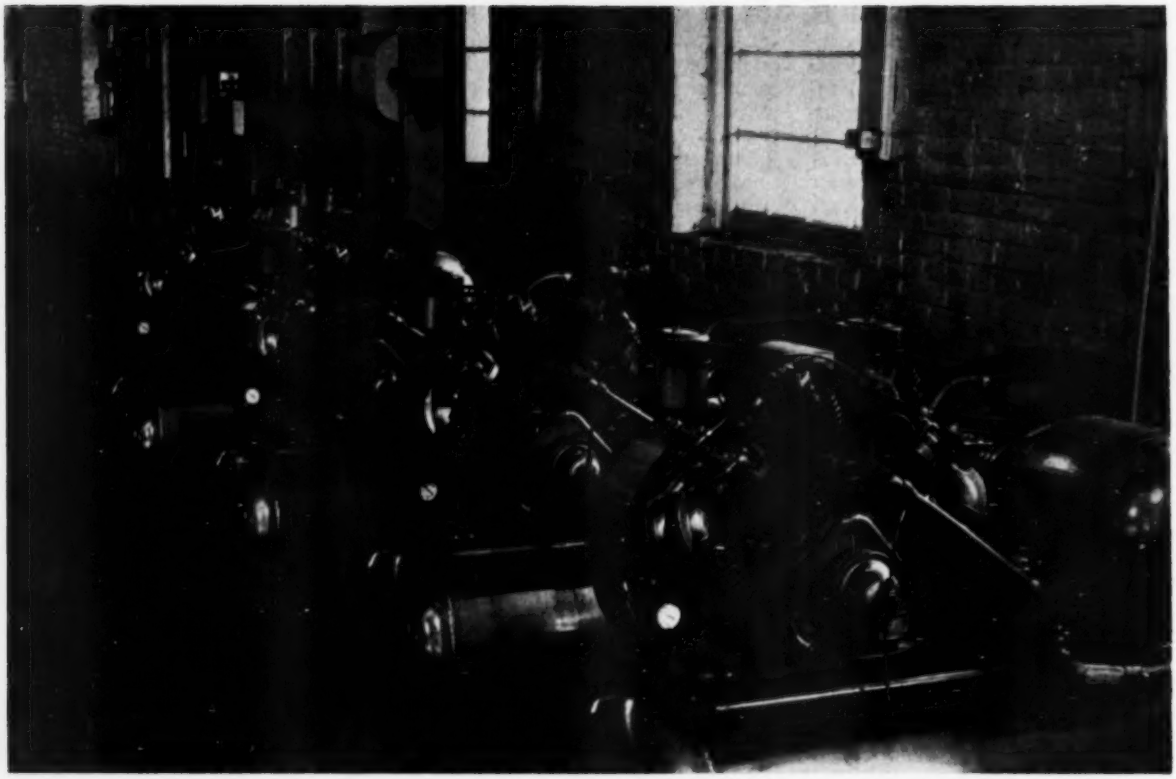


Fig. 4—Other examples are illustrated by the three phase pothead which may be enclosed in metalclad switchgear. If lug connections, right, are not insulated, full voltage to ground exists across porcelain. With connection insulated with tape, exposed creepage path is reduced but voltage gradient is also lower because part of creepage path is under the tape. However, the tape may be attacked by contaminants, reducing its resistance and changing gradients



This installation features four air compressors that can be operated simultaneously or singly according to air demand.

Decentralization of Air Supply Can Prove a Boon to Industry

Decentralization of large compressor equipment into several small compact units seems to be increasing in popularity. Individual units offer flexibility, economy and low cost.

R. P. ENINGER, *Wayne Pump* Co.

WHEN individually motorized machinery was first introduced, the resulting decentralization of power transmission was a boon to all industry. Power supplies were hand-tailored to the needs of each machine, and new efficiency and greater economy were the most obvious and logical results.

Today a similar revolution is taking place in the field of air power, with suspected similar beneficial results. Many plants are discovering a host of advantages in decentralizing their air supply, and substitution of a flexible, dependable, and economical system of smaller auxiliary air compressors located near the machinery they supply.

One of the outstanding features of this auxiliary unit plan is the insurance against total breakdown of plant air power. Although most large plants have a stand-by compressor ready in case of emergency, this machine may fail also during the time needed for repair of primary units. Such an event would mean total paralysis of every piece of air-operated equipment in the plant.

Even if both the main compressor and the emergency unit are in first-class condition, the cost of maintaining a normally idle machine, which is bound to deteriorate even during its period of idleness, is a waste of capital resources.

Dependability of the auxiliary unit plan is further enhanced by the fact

that trunk lines are completely eliminated. Friction loss, which materially reduces air pressure at the end of a long trunk line, becomes a negligible factor, and each department has the proper pressure and volume available, regardless of its location in the plant.

Flexibility

Moisture condensation in trunk lines, with resulting rust, scale, and general deterioration, also is vastly reduced in a system employing only multiple feeder lines. Air leaks are less costly, easier to find, simpler to repair, and affect only one department instead of the entire plant.

Another important factor is complete flexibility and adaptability. Long-range predictions regarding plant expansion are hazardous at best. Under the unit plan, air power keeps in step with plant growth and takes care of unforeseen eventualities as they arise.

A single large compressor, which may have been entirely adequate when it was first installed, will become less satisfactory as trunk lines are extended to take care of added machines, and a greater demand is placed upon the unit. The auxiliary unit plan, on the other hand, can never become outgrown.

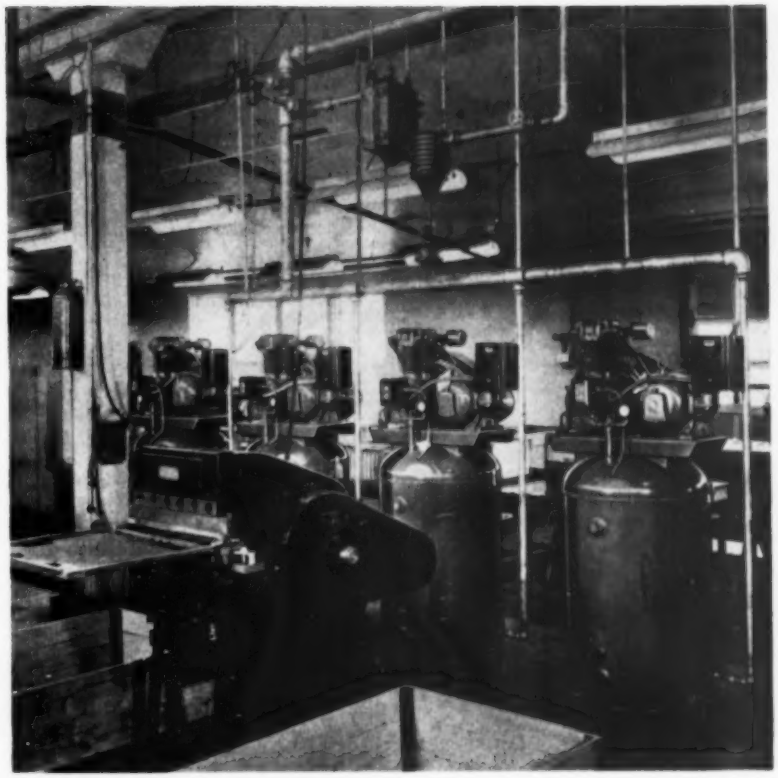
Fixed installations usually operate at pressures under 100 psi, despite the fact that many departmental uses require pressure up to 200 psi. In such cases, compressors of smaller displacement will not only provide the higher pressures but may also be adjusted to the precise pressure needed for any given operation.

Economies

Closely tied in with the flexibility is the possibility of major economies. The original investment in a new plant will almost certainly be lower, no expensive stand-by equipment is needed, trunk lines are eliminated, repairs can usually be done by an employee of the company, and no complete breakdown of power for the entire plant can ever occur.

It is hardly advisable to use a 200 hp compressor when only one or two departments are working overtime. The saving in power over a year's time can become a worthwhile item in the plant operation budget.

For plants already equipped with a single compressor system, the changeover can be as slow or as rapid as is desired. A few smaller units can first be installed in departments farthest removed from the pump source. Others can be added where higher pressures are needed for particular jobs. The whole conversion project may be spread over a period of years — or accomplished almost overnight.



These four individual air compressors are tied into a dryer to assure moisture free air. Additional units can be installed whenever conditions require.

This plan was adopted by a midwestern manufacturer of air conditioning equipment at a time the plant faced a period of rapid expansion. With no convenient location for a large compressed air plant and with no assurance of just how much air capacity would ultimately be needed, the company decided on the installation of a group of smaller units, which could be increased as the need arose.

Individual Operation

Units could be operated individually or in banks. By interconnection it was possible to increase or decrease the capacity of individual feeder lines to meet changing requirements, or to compensate temporarily whenever a compressor had to be shut down for service. As a result, the plant has never been without air power during production hours.

An additional saving was effected through the fact that drying equipment was needed only on the compressors employed for operations requiring clean, dry air. No driers were installed on units supplying other operations.

Ability of an auxiliary air unit to perform the job for which it is intended will depend upon the amount of usable air it makes available at operating pressures. Most manufacturers of air compressors rate their machines only on their displacement, not on actual air output.

Displacement ratings are only theoretical and can never be accepted as representing the usable air. Therefore, before buying any auxiliary unit, the purchaser should first check with the manufacturer to learn the amount of usable — not theoretical — air, which the machine is guaranteed to produce. Purchases based on horsepower or displacement ratings alone are likely to result in unsatisfactory and uneconomical performance in actual plant use.

New plants about to be equipped, plants undergoing expansion or extensive reorganization, and those which experience difficulty or dissatisfaction with the performance and over-all plant efficiency of a large central compressor system, should give careful consideration to the auxiliary unit plan.

It is first of all dependable, guaranteeing against costly breakdowns of the plant's entire air system. It can be handtailored to the changing needs of production. And it provides new economies in initial cost and maintenance.

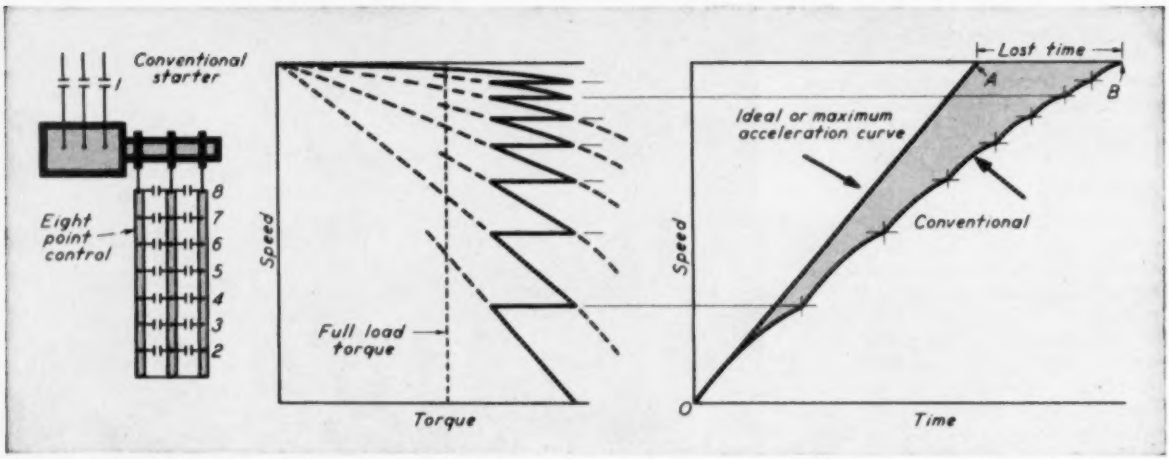


Fig. 1—Conventional wound rotor motor controls introduce resistance into only the slip ring, or secondary, circuit. Even with a number of steps, the horizontal shift between speed-torque curves on each step causes torque peaks and uneven acceleration that means the true acceleration curve is lower than the ideal curve with constant maximum torque.

Primary Resistance Control for . . .

Accelerating Wound Rotor Motors

. . . Reduces Time and Shock

Where heavy equipment must be started frequently and rapidly with minimum shock to the load, a wound rotor motor with a starter employing the best features of both primary and secondary resistance may be advantageous and save space as well. Here are explanations and design of the equipment.

W. J. HEACOCK
Electrical Engineer
Link-Belt Company

ONE OF THE PRINCIPAL advantages of the wound rotor induction motor, particularly in the larger sizes, is the possibility of choosing a speed-torque characteristic with a speed regulation anywhere between the minimum for induction motors and values well over 100 per cent, or even infinity. Closely related, of course, are the advantages of limited speed control and reduction of starting current, or kva, when the proper controls are used.

Often, however, wound rotor motors are used principally because the speed-torque characteristic can be adjusted to provide the torque values necessary to accelerate the load smoothly from standstill to full speed. The peak torques which occur during the starting periods of other types of induction motors, and which may be detrimental or even destructive to the driven equipment, can to a large extent be avoided.

The common method of controlling torque output of wound rotor motors is to start them with resistance in the secondary or slip ring circuit, cutting it out in several steps as the motor and load accelerate. Although peak torque may be limited to any desired value, the average value must be considerably lower, as later explained, and either accelerating time is increased or the peaks may be excessive and cause undesirable slippage or shock.

Advantages

The method using primary resistance as described herein produces a characteristic providing nearly constant torque through most of the speed range with a minimum of control equipment. Consequently, the method will be of interest and value for those applications in which too much time is lost in accelerating heavy loads, where accelerating-torque peaks must be limited to prevent slippage, or where space is a factor in a large battery of motors with conventional wound rotor controls.

As an example, this system was applied to the world's longest single belt

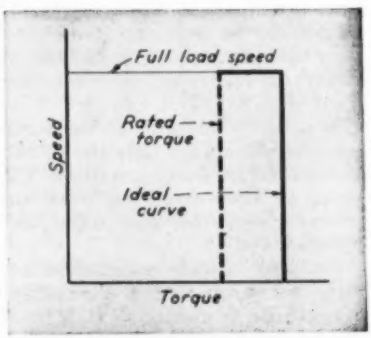


Fig. 2—The ideal speed-torque curve providing minimum accelerating time for limited torque conditions would be a vertical line at permissible torque. The torque limit is often determined by belt slip or mechanical strength, but driving torque should be as near to limit as possible up to full speed.

conveyor (10,900 ft centers) powered by a 200 hp motor. The acceleration is outstandingly smooth and satisfactory. Another example illustrating several advantages is an application involving a battery of eight Bird centrifugal filters. Only three contactors were used for each, resulting in a 50 per cent saving in space. Time for acceleration was reduced from 3 min to 2 min with no increased loading on the drive, resulting in a third less starting duty on the drives.

Conventional Control

The conventional control for wound rotor motors as illustrated at the left in Fig. 1 is familiar. This type of control has served well for a great many years. Basically, it provides an average torque for acceleration by cutting varying amounts of resistance from the secondary circuit of the motor, progressively, as the motor accelerates. As each section of resistance is switched out, the torque must increase (horizontally on the graph since speed does not change appreciably during the instantaneous switching operation) to the next higher curve determined by the resistance left in the circuit. The amount of change is necessarily limited by the peak torque which can be applied to the load.

Acceleration from this type of control is by no means uniform, and the peak torques contribute shock to the machinery and drives. If an upper limit is established for protection of the drive, then the time required for acceleration becomes unnecessarily long because motor torque falls off as the speed increases on each point. This leaves a lower torque margin for acceleration. Time required for acceleration cannot be calculated on a basis of the average torque of this curve but must be estimated using increments.

Fig. 1 also shows how time is lost during acceleration due to the conventional type of control. The wavy line OB indicates the uneven acceleration and rate under non-uniform conditions as compared with the shorter time of OA under a uniform torque equal to the maximum allowable. Therefore, OA would be the ideal curve.

Ideal Speed-Torque Curve

To obtain the ideal acceleration curve, a speed-torque characteristic as illustrated in Fig. 2 would be required. While this curve cannot be exactly duplicated, it is closely approached by the primary resistance system which has been used successfully for the past few years. Fig. 5 shows how close the approach has been.

The method consists of a combination of primary and secondary resistance and only three contactors. (If an additional low torque point is required one additional contactor is used.) The principles involved, taken separately, are not new, but the combination appears to be a new approach to the problem.

Design of Control Circuit

The first step, illustrated by Fig. 3, in design of the controlled circuit consists of adding just enough resistance to the secondary circuit to give maximum torque at standstill with full voltage applied to the stator.

As commonly used in calculating wound rotor motor secondary resistance, 100 per cent ohms is the value required, per leg, to give *rated full load torque* at standstill with full terminal voltage. Usually about 17 to 20 per cent ohms, including internal secondary resistance, will give *maximum torque* at standstill. This is readily determined from the name plate data on the motor. The internal resistance of the rotor, in per cent, may be taken as equal to the slip in per cent, or where full load speed is given,

$$\text{per cent slip} = \frac{\text{synchronous speed - full load speed}}{\text{synchronous speed}} \times 100 = \text{per cent internal resistance}$$

The external secondary resistance, to give rated full load torque at standstill, is easily determined since the rated horsepower output must be all dissipated as I^2R loss in the resistor at zero speed. The resistance per leg would then be calculated as

$$R = \frac{\text{hp} \times 746}{3 \times I^2} \text{ ohms}$$

This is less than the 100 per cent value to produce rated torque by the amount of internal resistance (or per cent slip). Therefore, the total (100 per cent) resistance in ohms is:

$$\frac{R}{100 - \text{per cent slip}} \times 100$$

As an example, assume a 60 hp motor with 1800 rpm synchronous speed and 1746 rpm full load speed and with a full load secondary current of 120 amp.

Per cent internal resistance equals per cent slip or:

$$\frac{1800 - 1746}{1800} \times 100 = 3\%$$

External resistance per leg for rated torque is:

$$\frac{\text{hp} \times 746}{3 \times I^2} = \frac{60 \times 746}{3 \times 120^2} = 1.04 \text{ ohms}$$

approximately, assuming secondary current remains 120 amp at full frequency. This is 100 - 3 or 97 per cent

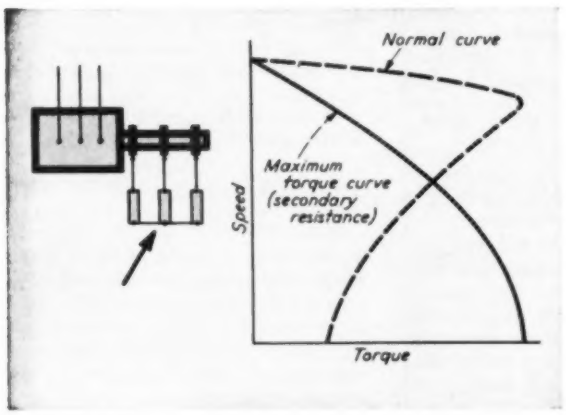


Fig. 3—Primary resistance alone cannot produce a suitable speed-torque curve because stator and rotor fluxes are out of phase. Primary resistance would reduce motor voltage which has effect of contracting normal curve horizontally.

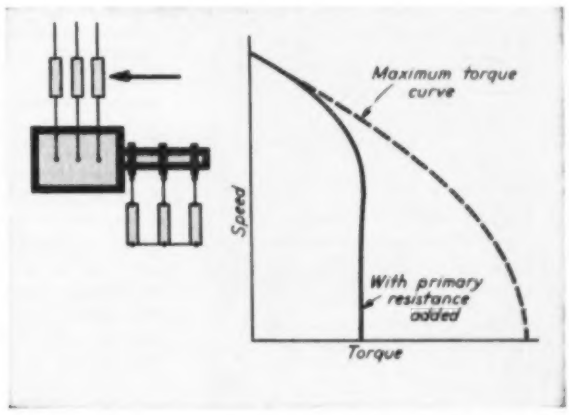


Fig. 4—With enough secondary resistance in the circuit to provide the maximum torque curve on full voltage, primary resistance reduces the low-speed torque values so that the actual curve is nearly vertical to about 75 per cent speed.

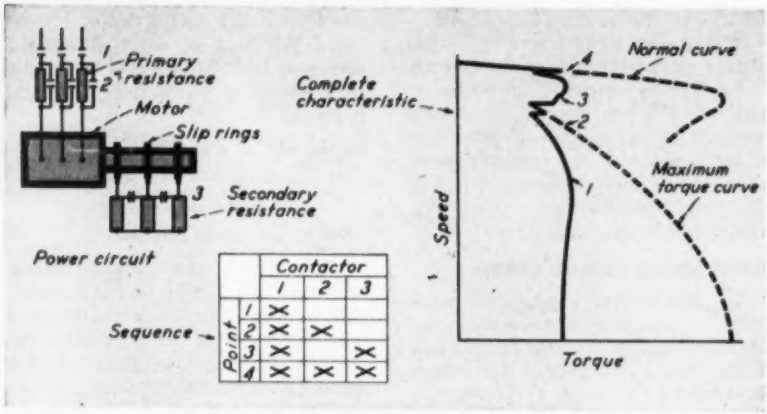


Fig. 5—By switching suitable amounts of both primary and secondary resistance at the proper time, a speed-torque curve approaching the ideal, Fig. 3, is obtained. The control uses only three contactors and two sections of resistance.

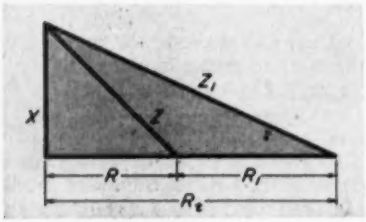


Fig. 6—Normally, motor reactance X may be taken equal to resistance R for maximum torque condition. Z_1 is resultant including primary resistance, R_1.

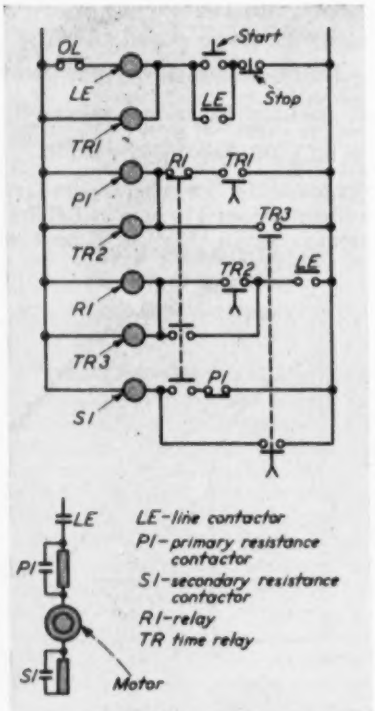


Fig. 7—Complete control contains the relays as required for timing, above, and protection needed against high torque as when load fails to start.

of the total resistance for rated torque at standstill. Therefore 100 per cent ohms is:

$$\frac{1.04}{97} \times 100 = 1.07 \text{ ohms}$$

External secondary resistance for maximum torque is:

$$(0.17 - 0.03) \times 1.07 = 0.15 \text{ ohm}$$

The maximum torque of most wound rotor motors is generally quite high and usually too high for the drive. In the conventional method of control, the torque is reduced by adding more resistance in the secondary circuit. It takes about 67 per cent ohms to develop 150 per cent of rated torque at standstill.

Limiting Torque

In the system being described, torque is reduced to the desired value, not by increasing the secondary resistance but by introducing some resistance in the primary circuit. This produces a speed-torque curve such as is illustrated by Fig. 4.

Since the motor torque is proportional to the square of the impressed voltage, it does not require a great amount of resistance in the primary circuit to reduce the torque to the desired value. The voltage at the motor terminals is reduced by the voltage drop in the primary resistance due to the flow of current in the primary circuit.

As the motor increases in speed, primary current decreases resulting in lower voltage drop across the primary resistance. This in turn increases the voltage at the motor stator terminals. The torque of the motor would also decrease if the terminal voltage remained constant, but since the voltage is increasing, the expected torque loss is compensated and torque remains at a constant or slightly increasing value. This, then, gives essentially constant torque up to something over 70 per cent of the motor speed. As torque drops off at higher speeds, the primary and secondary resistors are switched as necessary and the remaining points are about the same as with the conventional control.

Primary Resistance Value

The value of the primary resistance may be found from the formula whose derivation is given in the box at the end of this article. However, the following method is quite simple and the accompanying explanations are interesting.

It is necessary to know the maximum torque of the motor and the line voltage, together with the current the motor would draw at standstill with full voltage on the terminals and with secondary resistance to give maximum torque at standstill.

The first step is to determine what voltage must be applied to the motor terminals to give the required torque. Since torque is proportional to the square of the voltage, then

$$E_1 = \left(E^2 \times \frac{\text{required torque}}{\text{maximum torque}}\right)^{1/2}$$

where E is line voltage and E_1 is the required voltage.

For example, assume line voltage is 440 v, required torque is 150 per cent and maximum torque is 300 per cent:

$$E_1 = \left(440^2 \times \frac{150}{300}\right)^{1/2} = 310 \text{ v}$$

This result is primarily of academic interest and can be avoided in determining the current the motor will draw at the reduced voltage because current is proportional to the voltage (under given conditions at starting) and the square of either is proportional to torque. If I is the current the motor would draw at full voltage as outlined above, then the current, I_1, at the reduced voltage would be

$$I_1 = \frac{E_1}{E} \times I = \left(\frac{\text{required torque}}{\text{maximum torque}}\right)^{1/2} \times I$$

In the example, assume I for conditions given is 300 amp, then

$$I_1 = \frac{310}{440} \times 300 = \left(\frac{150}{300}\right)^{1/2} \times 300 = 211 \text{ amp}$$

Next, determine the reactance, X, of the motor. At the point of maximum torque, the reactance approximately equals motor resistance, or X= R. Note that R in this case is the equivalent value for the motor (including secondary resistance) as seen at the primary terminals.

Referring to Fig. 6, the impedance relation is

$$Z^2 = X^2 + R^2 = 2X^2$$

$$Z = 1.41 X$$

Therefore, in the example,

$$Z = \frac{E_1}{1.73 \times I} = \frac{440}{1.73 \times 300} = 0.85 \text{ ohm}$$

$$R = X = \frac{0.85}{1.41} = 0.6 \text{ ohm}$$

The impedance, Z_1, necessary in the circuit to give 211 amp is

$$Z_1 = \frac{E}{1.73 \times I_1} = \frac{440}{1.73 \times 211} = 1.2 \text{ ohm}$$

The final step is to determine the external primary resistance, R_1.

$$Z^2_1 = X^2 + (R + R_1)^2$$

In the example

$$R + R_1 = (Z^2_1 - X^2)^{1/2}$$
$$= (1.2^2 - 0.6^2)^{1/2} = 1.04 \text{ ohm}$$
$$R_1 = 1.04 - 0.6 = 0.44 \text{ ohms}$$

A short formula for this particular case, wherein X is equal to R, is:

$$R_1 = Z \left[\left(\frac{1}{P} - \sin^2 \theta \right)^{1/2} - \cos \theta \right]$$

$$= Z \left[\left(\frac{1}{P} - 0.5 \right)^{1/2} - 0.707 \right]$$

where P is the desired fraction of full voltage maximum starting torque.

As a check, substituting for Z the value previously found, 0.85 ohm, and for P, one-half (of 300 per cent) torque:

$$R_1 = 0.85 \left[\left(\frac{1}{\frac{1}{2}} - 0.5 \right)^{1/2} - 0.707 \right] = 0.44 \text{ ohm}$$

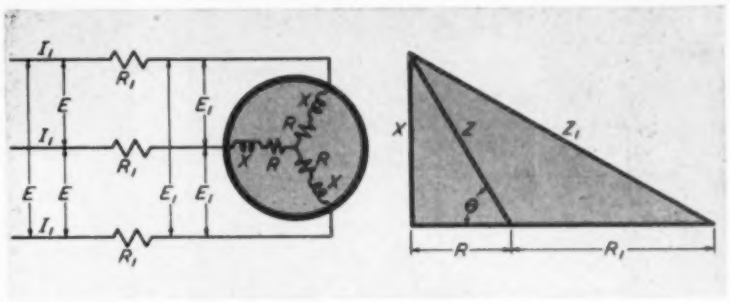
The thermal ratings of the resistors used must be selected on a basis of the current the resistor will carry and the length of time the resistor is in the circuit.

Control Circuit

Fig. 5 shows the complete power circuit and resulting speed-torque characteristics. Note that only three contactors are required but four points are obtained. This is accomplished by using number two contactor twice. A conventional control with seven or eight contactors would give an average torque available for acceleration that is somewhat less, therefore requiring more time for acceleration.

Fig. 7 is an elementary diagram for the control using primary resistance for starting.

There are some unfavorable aspects to this type of control. Just as it stands, it cannot be used for speed regulation in the ordinary sense. If a wound rotor motor is used because of a limited power source this method would not be as suitable as other starting schemes which produce a lower kva demand. However, there is some cushioning effect on the power supply as compared to across-the-line starting.



DERIVATION OF FORMULA FOR FINDING PRIMARY RESISTANCE FOR REDUCED TORQUE STARTING OF WOUND ROTOR MOTORS

The methods used in the preceding article to find the value of the primary resistance that will produce the optimum speed-torque curve for accelerating wound rotor motors involved short cuts to save calculations. The following derivation gives the formula which may be used where assumptions made in the article are not true.

Introducing resistance into the supply circuit of an induction motor primarily has the effect of reducing the voltage across the motor terminals. On the other hand, introducing resistance into the secondary circuit not only limits current by increasing the impedance of the motor but it also provides a variety of speed-torque characteristics by changing the phase relationship between the rotor and stator fluxes.

In the description of the operation of the starting control and in the following derivation of the formula by A. Antonio, it should be noted that primary resistance does not change the motor characteristics (except to have the effect of contracting the curve horizontally as terminal voltage decreases). The speed-torque characteristic having the maximum starting torque (for any given voltage) is determined for the motor by inserting the proper amount of secondary resistance. The relation between internal reactance and resistance is therefore fixed at zero speed for which the calculations are made.

The voltage rising across the primary resistance as speed increases causes the contracted maximum-torque characteristic to expand horizontally towards its full voltage value. This allows the actual speed-torque curve on the first control step (with both primary and secondary resistance in) to be almost vertical.

In the proper derivation of the formula to find primary resistance needed, it can be shown that, since torque is proportional to the square of the voltage, it is also inversely proportional to the square of the total impedance of each phase (see above sketch).

However, several steps may be avoided and the same conclusion becomes apparent if it is noted that torque is also proportional to the square of the motor current (for a given relation between internal, or equivalent, reactance and resistance, which includes all resistance in the secondary circuit as well) and that, by Ohm's Law, current is inversely proportional to total impedance.

Therefore

$$Z_1 = \frac{Z}{P^{1/2}}$$

where

Z = motor impedance (each leg)

Z_1 = impedance with resistance in the primary circuit, and

$$P = \frac{\text{reduced or desired torque}}{\text{maximum torque at rated voltage}}$$

The impedance diagram, above, of one leg of the wye connected load shows the relation between the reactance X, resistance R, and impedance Z of the motor for maximum torque conditions, and added primary resistance R_1 and total resultant impedance Z_1. From this diagram

$$Z^2_1 = X^2 + (R + R_1)^2$$

Substituting $Z/P^{1/2}$ for Z_1 and

$$R = Z \cos \theta$$

$$X = Z \sin \theta = Z (1 - \cos^2 \theta)^{1/2}$$

and solving for the desired value, R_1, by using the quadratic formula

$$R_1 = -Z \cos \theta \pm Z \left(\frac{1}{P^{1/2}} - \sin^2 \theta \right)^{1/2}$$

The first term on the right-hand side of the equation is the equivalent resistance of the motor circuit (as seen at the motor terminals). Therefore, since the whole right side is equal to the external resistance of the circuit, the second term must be the total resistive component (the entire base of the impedance triangle above) and must be positive. Rewriting the equation with the positive sign,

$$R_1 = Z \left[\left(\frac{1}{P} - \sin^2 \theta \right)^{1/2} - \cos \theta \right]$$

Since $\cos \theta$ is the power factor and since

$$\sin^2 \theta = 1 - \cos^2 \theta$$

the equation may be rewritten in terms of power factor as

$$R_1 = Z \left[\left(\frac{1}{P} + \cos^2 \theta - 1 \right)^{1/2} - \cos \theta \right]$$

This is the desired value of R_1, the resistance in ohms to be added in each leg of the primary circuit to reduce the maximum starting torque to the required value. The quantities necessary for solving are easily available:

Z = impedance of the motor with the required amount of secondary resistance for maximum starting torque

= line voltage divided by line current under normal, full voltage, maximum torque conditions at starting

$\cos \theta$ = power factor of the motor under normal, full voltage, maximum torque conditions at starting, and

P = ratio of desired or reduced torque to maximum starting torque

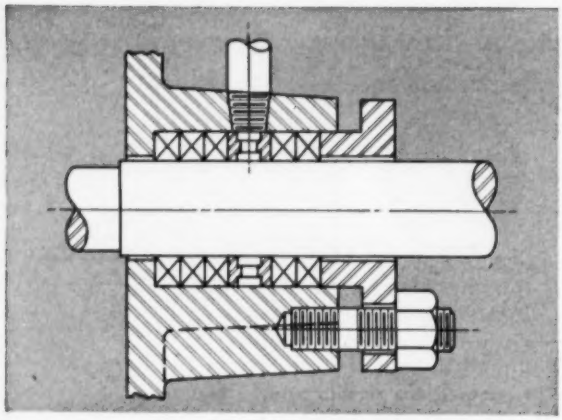


Fig. 1—To prevent air leakage into the pump, when under a vacuum, a seal cage is fitted into the stuffing box.

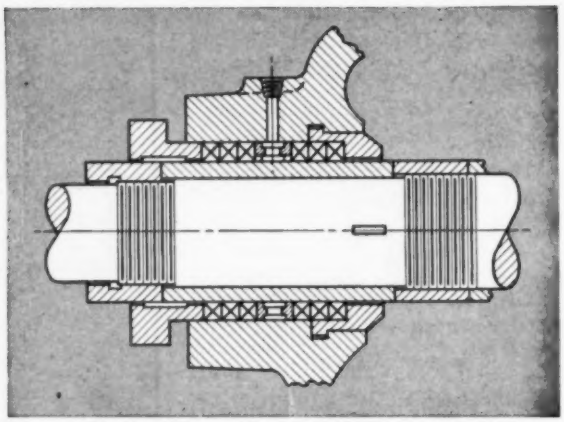


Fig. 3—Stuffing boxes are sometimes fitted with throat bushings, which are removable and form the box bottom.

Centrifugal Pumps . . .

Stuffing Boxes, Packing, and Pressure Reducing Devices

Fig. 2—Water seal cage is generally split axially for ease of assembly.

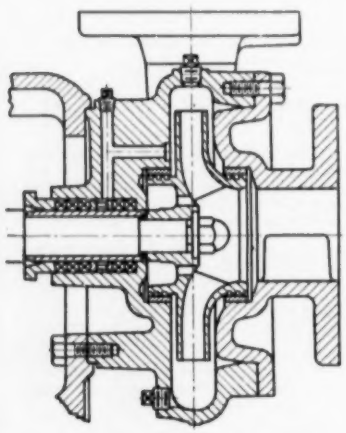


Fig. 4 — Sealing liquid is introduced into space through internal passages.

Here are the basic details of stuffing boxes, packing, and pressure reducing devices that are applied in designing a centrifugal pump. Variations of these items are clearly brought out to give the engineer a well rounded understanding of their importance in the pump.

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Worthington Corporation

ONE of the most important elements in any centrifugal pump is the stuffing box. And, a very slight defect in its arrangement or condition can affect operation to a very serious degree.

All stuffing boxes, regardless of service, have one main function, that of packing the shaft against leakage where it passes out through the pump casing. However, there are several variations of this function and of the manner in which it is performed. Thus, the function of the stuffing box is to prevent leakage of air into the pump when the pressure at the interior end of the stuffing box is below atmospheric pressure. When this pressure is above atmospheric pressure, the function is to prevent leakage of the liquid out of the pump.

Some stuffing boxes are fitted with a throat bushing, which is a removable piece forming the bottom of the stuffing box. This bushing is always solid rather than split, even though the casing in which it is fitted may be axially split. It is generally held from rotation by a locked tongue-and-groove joint in the lower half of the casing, Fig. 3.

Use of stuffing box throat bushing is based mainly on manufacturing problems rather than on any particular advantage in operation. They are generally applied to pumps of small size, when the diameter of an integrally

This article will be included in a book on centrifugal pumps now being prepared by the authors; hence, all rights to republication are reserved by them.

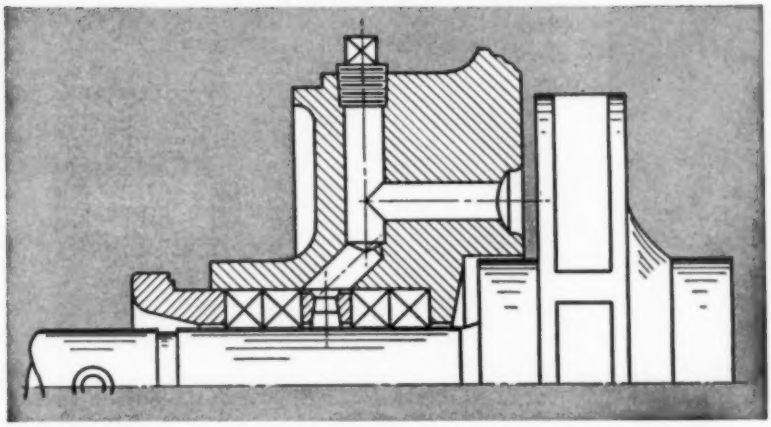


Fig. 5—General service arrangement when the pumped liquid is employed for sealing internal path. Note external passage is sealed off with a pipe plug.

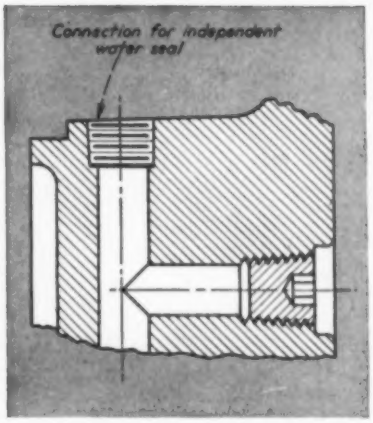


Fig. 6—When independent seal is used the internal passage must be plugged.

formed stuffing box throat would limit the size of the boring bar used to machine the casing to an impractically small diameter. They are also employed on pumps when the bottom of the stuffing box is subject to severe wear because of abrasive pumping conditions. The bushing then can be replaced when necessary, to restore original clearances.

Seal Cages

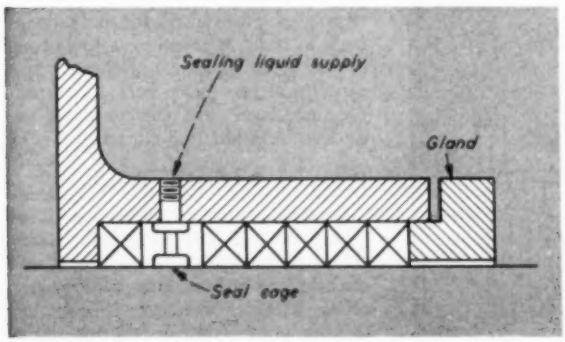
In order to provide against air leakage into the pump, when operating on a suction lift or under a vacuum, a water seal cage or lantern ring is fitted into the stuffing box, as in Fig. 1. For ease of assembly, seal cages are generally split axially, as shown in Fig. 2. Water or sealing fluid under pressure is piped to the chamber formed by this seal cage and makes an effective seal beyond which air cannot pass into the pump. This seal chamber also provides a reservoir of water or fluid for cooling and lubricating the packing rings. A seal may also be used to prevent the outflow of the pumped liquid into the atmosphere when this liquid is inflammable or chemically active and dangerous.

Certain installations involve variable suction conditions, where the pump operates part of the time with a head on the suction and part of the time with a suction lift. When the pressure inside the pump is above atmospheric, the function of the water seal cage is inoperative (except for lubrication) when the pump is in operation. However, it is still provided so that when priming the pump at starting all the air can be excluded.

When the pump is handling clean cool water, stuffing box seals are usually connected to the pump discharge or, in the case of multistage pumps, to an intermediate stage. An independent water sealing supply should be provided under the following conditions:

1. When suction lift exceeds 15 ft.
2. When the discharge pressure is less than about 10 psig or 23 ft head.
3. When pump is handling hot water over 250 F, where adequate cooling is not otherwise provided. (except in boiler feed service.)
4. When the water is muddy, sandy, or gritty.
5. On all hotwell pumps.
6. In general, when the liquid handled is other than water, such as acid, juice, molasses, or sticky liquids, and no special provision is made in the design of the stuffing box for the liquid handled.

In some pumps, the connections to the seal cage are arranged so that the sealing liquid can be introduced into the packing space through either an internal drilled passage from the pump casing or from an external source, using either clear water or some other sealing fluid. Such a construction is illustrated in Fig. 4, while Fig. 5 and 6 illustrate the use of the seal cage connection. In Fig. 5, which is the general service arrangement where the pumped liquid is used for sealing, the external connection is plugged. When an external



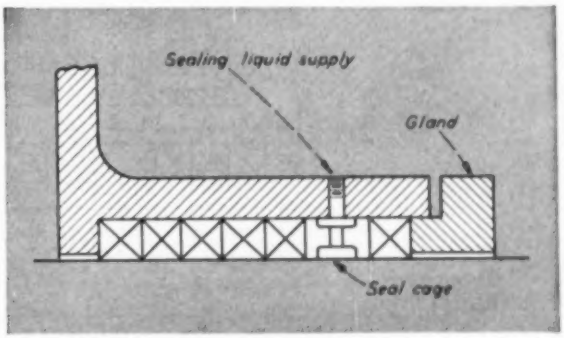


Fig. 7—Liquid seal cages should be close to the pump interior, left, when an abrasive liquid is handled, so clear liquid will keep the packing free of abrasive. Liquid seal cages are located at extreme end when pumping clear liquid.

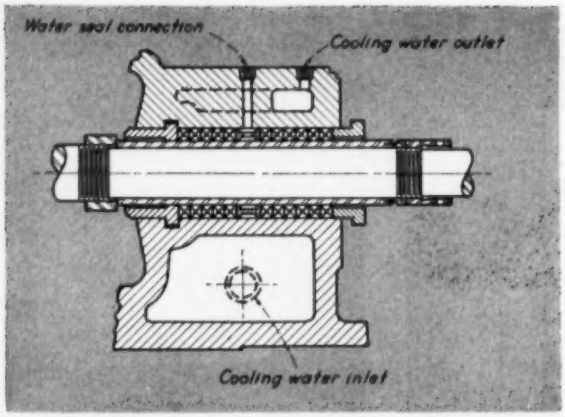


Fig. 8—Cored passages in this pump casing casting, which surround the stuffing box, are utilized for heat removal.

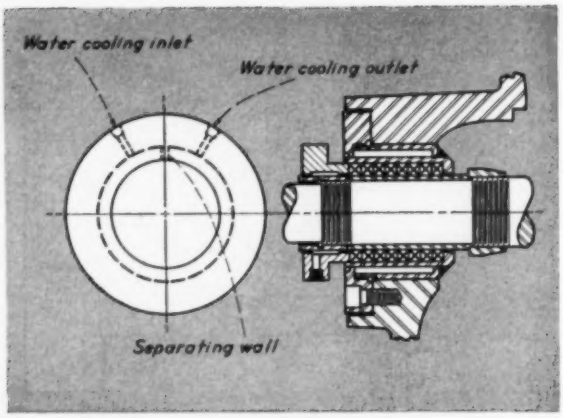


Fig. 9—Separate cooling chamber is combined with stuffing box. The unit is assembled and inserted into casing.

source of sealing water is required, it is connected to the external pipe tap and a socket head pipe plug inserted at the internal pipe tap, as in Fig. 6.

Seal cages should be close to the pump interior when an abrasive liquid is handled, so that the clear sealing liquid will flow into the pump and keep the packing free from abrasives. When the minimum of dilution is desired, the seal cage should be located away from the pump interior. The recommended locations of the seal cage are illustrated in Fig. 7.

For intermittent service and other duties when water or other clear liquids cannot be used or are not available, a grease seal may be effective. Weighted grease sealers are available and are frequently used with chemical pumps to avoid dilution. This type of seal is also frequently used on low head drainage pumps operating with a suction lift and often with a discharge pressure below atmospheric because of a syphon system. Grease seals are also very frequently used on pumps handling sewage.

Water Cooled Stuffing Boxes

Problem of maintaining the packing in a stuffing box is made more difficult with high temperatures or high pressures. Pumps handling hot liquids or having stuffing boxes subject to high pressures are generally provided with water jackets to which cooling water is supplied. This cooling water removes heat from the liquid leaking through the stuffing box as well as heat generated by friction in the stuffing box, thus improving the conditions under which the packing has to operate. (In some special cases, oil or gasoline may be used in the cooling jackets instead of water.)

Two different methods are available for the construction of water cooled stuffing boxes. The first, illustrated in Fig 8, consists of providing cored passages in the casing casting. These passages, which surround the stuffing box, are arranged with in and out connections. The second uses a separate cooling chamber combined with the stuffing box proper, the whole assembly being inserted into and bolted to the pump casing, as in Fig. 9. The choice between the two is made principally on the basis of individual manufacturing preferences.

Of course, the limiting pressure and temperature conditions against which it may be possible to pack a stuffing box vary with the type of pump in question. Actually, it may not be economical to equip a pump normally intended for moderate service conditions with an expensive type of stuffing box for the infrequent application when such a construction would be needed. Therefore, whenever the limitations imposed by the manufacturer on the stuffing box conditions for a given pump are exceeded, the only solution resides in the application of pressure reducing ahead of the stuffing box proper. Since the design of such devices has now reached a high degree of proficiency, the only drawback to their application is the necessity of bleeding a part of the effective capacity of the pump back to a lower pressure level and the resultant reduction in installation efficiency.

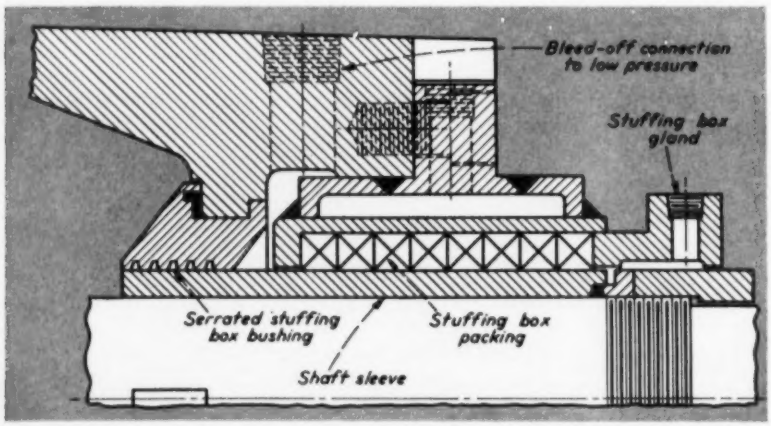


Fig. 10—This pressure reducing device is suitable for limited pressures. The short serrated stuffing box bushing permits leakage, which is bled to low side.

Pressure Reducing Devices

Essentially, these devices consist of a bushing or meshing labyrinth located between the pump interior and the stuffing box proper and ending in a relief chamber. The latter is connected to some point in the installation where a suitably low pressure is established and the leakage past the pressure de-

vice is returned to this point. When the liquid pumped must be salvaged, as for instance in the case of treated feedwater, it is returned into the pumping cycle. If, on the other hand, the liquid can be wasted, the relief chamber may be connected to a drain.

There exists a great number of different designs of these pressure reducing devices. Fig. 10 illustrates one such device suitable for limited pressures. In this particular case, a short serrated stuffing box bushing is inserted at the bottom of the stuffing box and is followed by a water seal cage, which fulfills the function of the relief chamber. The leakage past the serrated bushing is bled off through a connection to a low pressure point.

When relatively high pressures on stuffing boxes are encountered, labyrinths of the intermeshing type may be located ahead of the stuffing box. They may likewise be located on the discharge side, where they follow the balancing device and precede the stuffing box. It should be noted that the piping from the leakoff chamber following such pressure reducing devices should be amply sized so that, as wear takes place and leakage increases, there will not be an appreciable increase of friction in the leakoff piping and a subsequent increase of the pressure at the stuffing box.

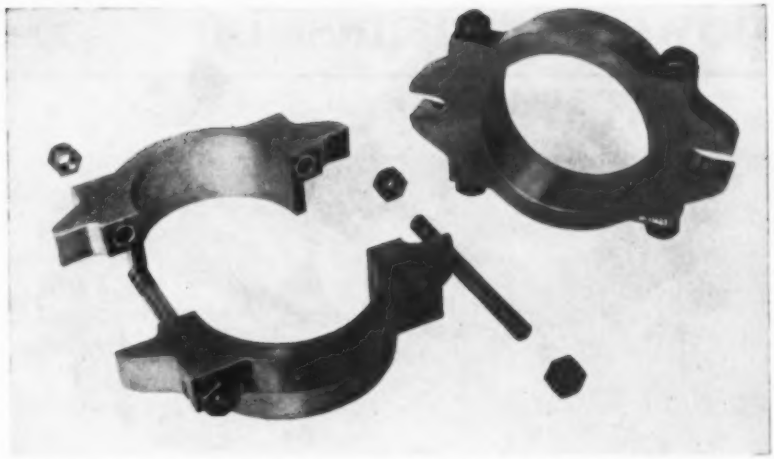


Fig. 11—Stuffing box glands can be either solid or split. Those above are made in halves so they can be removed from shaft without dismantling pump.

Stuffing Box Packing

There are numerous types and materials of stuffing box packing, each especially adapted to some particular class of service. Some of the principal types are graphited asbestos packing and metallic packing rings.

Graphited asbestos packing is comparatively soft and is suitable for cold water and hot water applications in the lower temperature range. This packing is generally supplied in continuous coils of square cross-section and in various sizes. To be ready for use, it is cut off from the coil in lengths to make individual rings. The ends are cut at a slight angle with a slight clearance to provide for expansion so as to prevent *buckling*. This packing is good for general service under normal pressures and is the most commonly used. For pressures beyond 200 psi, this packing is not suitable, except at very moderate rubbing speeds.

Metallic packing rings are composed of a flexible metallic coil with graphite lubricant and squared to the proper size. This packing is self-lubricating for its starting-up period, as the foil is impregnated with oil and graphite under compression, permitting the oil to flow to the surface of the moving shaft or sleeve. The foils are made of various kinds of materials such as babbitt, aluminum, or copper. Babbitt foil is used for low and medium temperatures in water and oils (up to 450 F) and medium to high pressures. Copper is used for medium to high temperatures and pressures in water and low sulfur content oils. Aluminum is mainly used in oil service, also for medium to high pressures and temperatures.

Standard practice is to obtain this packing in ring rather than coil form, die-molded to exact size. For best results, the shafts or hardened sleeves, which are preferred, should be in perfect alignment and concentric with the axis of rotation, operate without vibration, and be highly polished. Choice of shaft or shaft sleeves material is extremely important to the life and maintenance of metallic packing. Some packing sets are often made in combinations of alternating hard and soft rings, which give very good results.

Many other types of packing are commonly furnished to meet customers' special specifications, such as hemp, cord, braided type, duck fabric, chevron type, and others too numerous to mention.

Stuffing Box Glands

Stuffing box glands may assume several forms, but basically they can be classified into two groups: solid glands and split glands.

Split glands are made in halves so that they may be removed from the shaft without dismantling the pump to provide more working space when the stuffing boxes are being repacked, Fig. 11. They are desirable on pumps that have to be repacked frequently, especially if the space between the box and and the bearing is too restricted. The halves of split glands are generally held together by bolts, although other designs are available. Split glands are generally a refinement of construction, not a necessity, and are rarely used in the smaller sizes of pumps. They are quite commonly furnished for large size single-stage, some multistage, and refinery pumps.

Another refinement, often used, consists of swing bolts in connection with stuffing box glands. This permits swinging the bolts to the side, out of the way, when it becomes necessary to repack the stuffing box.

In a great many applications, the stuffing box leakage, if permitted to issue unimpeded into the atmosphere, could give rise to serious inconveniences, if not actually danger to the operating personnel. This is frequently the case with centrifugal pumps handling liquids such as hydrocarbons at temperatures above their flash point or vaporizing temperatures. As this leakage cannot, in some cases, be cooled sufficiently by the application of water cooled stuffing box, smothering glands are used. In such a gland provision is made to introduce a liquid, either water or another hydrocarbon at low temperature, that mixes intimately with the leakage. This lowers the temperature or, in the case of volatile liquids, absorbs the leakage.

Stuffing box glands are generally made of bronze, although cast iron or steel may be used for all iron fitted pumps. Where used for refinery service when the fluid pumped may give off inflammable vapors, which may ignite from sparks generated between the gland and the shaft or sleeve if both are made of ferrous metal, iron, or steel, the glands are generally bushed with a non-sparking material.

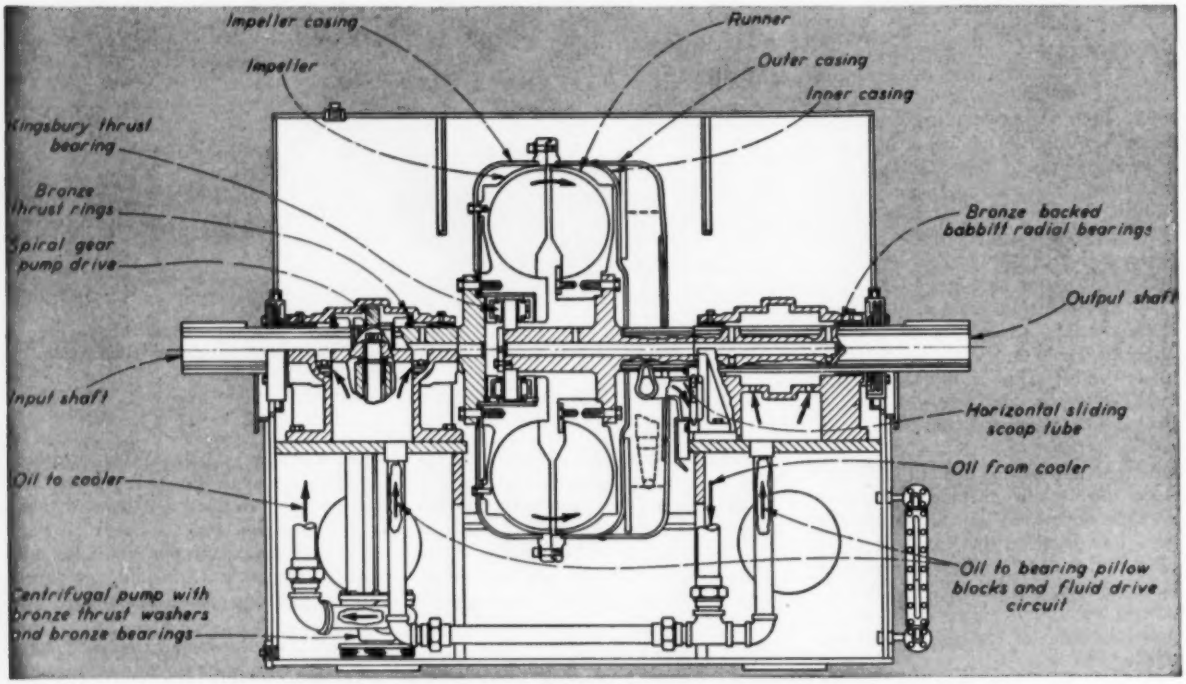


Fig. 1—Cross section of an adjustable speed fluid drive that employs a sliding scoop tube to vary the driven speed.

Adjustable Speed Fluid Drives-1

Part 1 presents basic principles of adjustable speed fluid drives. Part 2, to be published next month, will discuss specific plant applications.

R. C. HABICHT, *Engineer*
American Blower Corporation

ADJUSTABLE SPEED FLUID DRIVES consist of four basic elements—an impeller, a runner, one or more casings, and some means of changing the oil filling during operation to obtain an adjustable output speed.

There is no mechanical connection between the impeller or primary rotor and the runner or secondary rotor. Power is transmitted from the impeller to the runner entirely by a vortex of oil. The impeller acts as a centrifugal pump and imparts energy to and accelerates the oil radially outward. The runner acts as a reaction turbine and absorbs the kinetic energy in the oil as it passes from the outer periphery toward the axis of rotation. This circulation of oil between the impeller and runner is known as the working circuit. The casings are attached to the impeller and serve to confine most of the oil to the working circuit, to provide a chamber in which a scoop tube can act to remove oil from the working circuit, and to add mechanical strength to the rotating assembly.

Basic laws, which govern any centrifugal machine, also govern a fluid drive. For a given size at a given slip the horsepower transmitting capacity varies as the cube of the input speed. At a given speed and slip the capacity varies as the fifth power of the diameter. Torque is always transmitted at a 1 to 1 ratio. There are many different mechanical designs depending on the particular application. One type

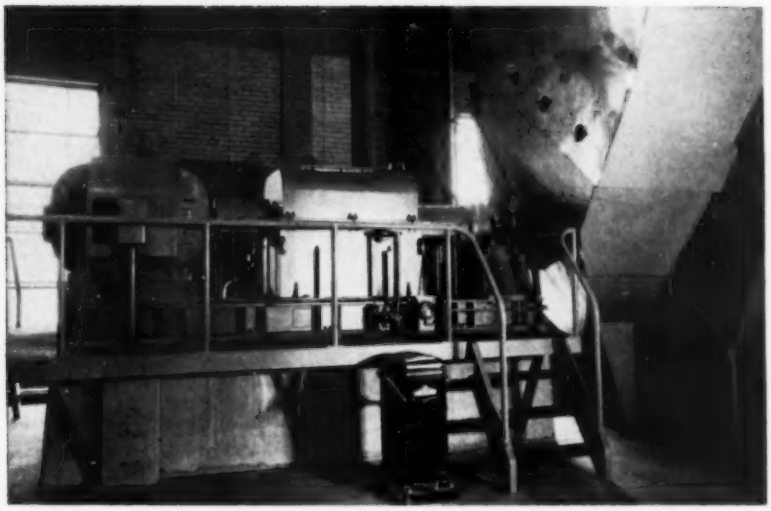


Fig. 2—Induced draft fan, driven with a 600 hp induction motor through a 27-in. fluid drive, delivers a maximum of 181,000 cfm at 310 F and 12 in. sp.

drive is designed in a series of sizes for operation at 3600 rpm and has been built to transmit as much as 12,000 hp at this speed. Another type is built in a series of eight sizes for from 100 to 2500 hp at normal motor speeds of 1800 rpm and lower. The construction and operation of both types, however, are similar.

Fig. 1 shows the cross section of a fluid drive that employs a sliding scoop tube as the means of changing the oil filling for adjustable speed operation. The entire rotating assembly is enclosed in a welded steel housing, which is split on the horizontal shaft centerline for easy access to the rotating parts. The bottom portion of this housing is heavily cross braced to carry the weight of the rotating parts. It also acts as an oil reservoir or sump from which the lubricating and operating oil is supplied to the unit.

A centrifugal pump, gear driven from the impeller shaft, picks up oil from this tank and sends it through an external oil cooler. On the entering side of the cooler, a portion of the oil is bled off through an oil filter and returned to the tank. From the cooler the oil is returned to the piping inside the tank and is divided into two circuits that flood the impeller and runner pillow blocks. The two bronze backed babbitt radial precision bearings in each pillow block, as well as the pump driving and driven gears in the impeller pillow block, are lubricated by this oil.

From the pillow blocks, oil passes through radial holes in the shaft and into the center of the hollow shafts. The Kingsbury thrust bearing, located in the back of the impeller, is lubricated as the oil is forced through the shafts and into the working circuit between the impeller and runner.

Oil is held in an annular ring in the working circuit by centrifugal force. A series of openings between the working circuit and the scoop tube chamber allow a free flow of oil between these two chambers. Therefore the centrifugal oil level in the working circuit can be adjusted by varying the oil level in the scoop tube chamber. Although the scoop tube is projected to a vertical plane, Fig. 3, it actually works, by a horizontal push-pull action.

Scoop Tube Action

The scoop tube acts as a sliding weir to set the oil level in the scoop tube chamber and therefore in the working circuit. When the tip of the scoop tube is extended toward the outer casing, the oil filling in the circuit is reduced and the output speed decreased. As the scoop tube is withdrawn toward the center of the unit, the circuit is allowed to fill with oil and the output speed is increased. Except during periods when the speed is being changed, the scoop tube handles a constant volume of oil and returns that oil to the reservoir.

In general, variable speed fluid drive applications can be classified as either variable or constant torque. Constant torque loads, where the horsepower varies directly with the speed, are found with such machines as reciprocating pumps, conveyors and ball mills. When loads of this nature are less than 100 hp, a fluid drive different in construction than the one described above, is usually used.

Numerous Applications

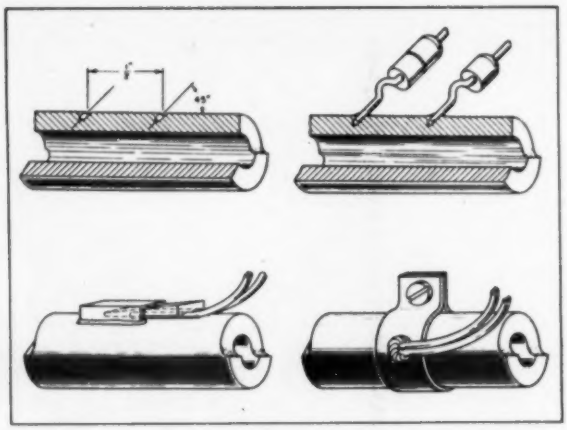
Fluid drive is ideally suited for adjustable speed operation of variable torque machines such as centrifugal pumps, blowers, compressors, and fans. On a mechanical draft fan, for example, Fig. 2, the fan horsepower varies as the cube for the speed. Therefore at reduced ratings, variable speed is a more efficient method of volume control than any type of mechanical orifice such as dampers or vanes. Fluid drive offers additional advantages in that the controlling mechanism is completely divorced from the effects of high temperatures and abrasive materials, which may be present in the air or gas stream. Also wear on the bearings and rotors of the driven machine is reduced to the minimum since it always operates at the minimum speed consistent with the volume requirements.

Fig. 3—Scoop tube acts as a sliding weir to maintain the chamber oil level. When tip is in outward position speed is reduced as less oil is in chamber.

Techniques for . . .

Measuring Boiler Tube Temperatures

F. D. DODGE, *Application Engineer, Minneapolis-Honeywell Regulator Co.*



Several methods for installing thermocouple wires are shown at right. These include peening into drilled holes, fastening with bracket and wedge, and welding to clamp.

SAFE OPERATION of modern steam generators depends in a large degree on accurate measurement of tube temperatures. The high temperatures and pressures at which these boilers operate have minimized many conventional safety factors, leaving tube temperature readings the most readily available guide to reducing operational hazards.

Temperature Measurement

Many plants utilize properly installed thermocouples and high speed scanning systems so an operator can immediately locate an excessively hot tube. As added protection, the scanning system can be arranged to actuate both audible and visible alarms when any one temperature exceeds its set point. The operator, thus alerted, studies the strip chart record, easily spots the hot tube, and begins corrective action. Thus, proper steam distribution is maintained, and costly shutdowns as a result of tube failures are prevented.

Since some tubes in a boiler normally operate at higher temperatures than others, Minneapolis-Honeywell has designed high speed scanning systems that provide as many as 270 temperature readings at the rate of one per second. Temperature points are arranged in banks of 18, and each bank can have any set point within the range of the scanner system. The value of the temperature and its identifying number are clearly printed for immediate reference.

Installing Thermocouples

However, the value of the finest temperature measuring equipment can be nullified by improper thermocouple installation. This contingency can be avoided by utilizing one of the following recommended installation techniques. Each method assures a positive contact between the temperature-sensitive element and the boiler tube.

1. Spot temperature measurement—The thermocouple measuring junction is welded to the boiler tube. Installation is inexpensive and easy.

2. Average temperature measurement—The thermocouple measuring junction is broken and one wire of the couple is welded to the boiler tube; the other wire of the couple is welded to the opposite side of the tube. The measuring instrument when connected to this couple indicates the average of the two temperatures at the welds.

3. Thermocouple peened into drilled holes—Holes are drilled either vertically or at a 45 deg angle, ½ in. apart, and to an approximate depth of 1½ times the diameter of the thermocouple wire. Then the wires are inserted and peened into place. Some plants give the wire and insulation additional protection by fastening the wires to the tube with a Chromel strap and covering the assembly with alundum cement containing five per cent loose asbestos. This method requires no welding, but peening may be difficult in cramped quarters. The union is likely to be less secure than welding, and the wall thickness of the tube is reduced at the recess.

4. Wires held in a small steel tube welded to the boiler tube—A small diameter steel tube is welded to the boiler tube. The thermocouple measuring junction is placed within the steel tube and flattened with a hammer, thus holding the thermocouple securely in place. The thermocouple junction is easy to install, but the steel tube is difficult to attach.

5. Bracket and wedge—A small bracket is welded to the boiler tube. The thermocouple wires then are inserted and fastened securely by driving the wedge into place. The advantages and disadvantages are the same as when using the steel tube.

6. Thermocouple wires welded to clamp—Wires are welded to a pipe clamp, which can be attached to the boiler tube at any desired point. The clamp should be of stainless or molystabilized chrome steel to prevent corrosion and oxidation. Mounted by this method, thermocouples are easy to install and replace.

7. Nut and bolt—A nut having a small hole drilled through its side is welded to the boiler tube. The thermocouple wires are inserted into the hole and a bolt is screwed into place forcing the wires firmly against the tube. Again, the problem is in welding the nut to the tube.

8. Protected thermocouple for superheater tube temperature measurement—This thermocouple is designed for extremely long life. Its stainless steel construction makes it particularly durable. The method of fastening to tubes is similar to the bracket and wedge method. Although long life is assured, the protected thermocouple is more expensive than the unprotected ones.

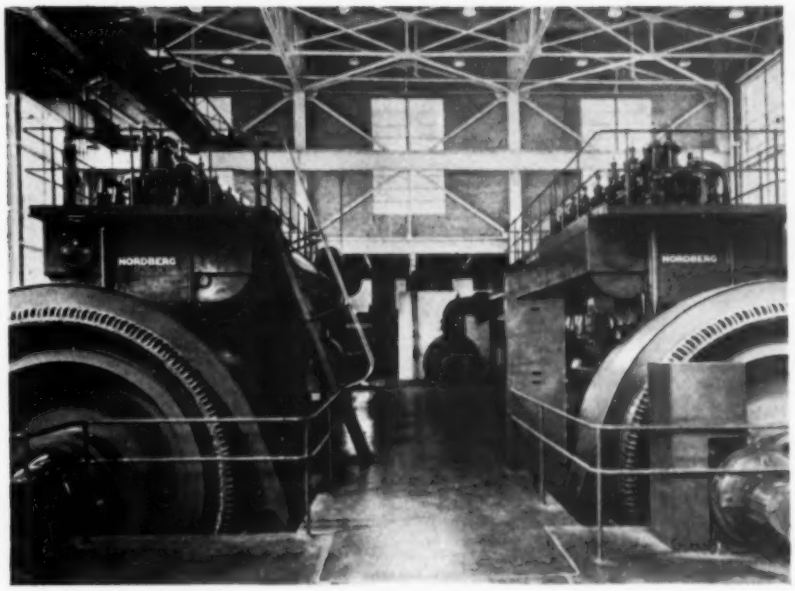
Thermocouple Materials

Thermocouples made of 14 or 20 B&S gage wire have been found adequate for superheater tube installations. The 14 gage is usually used because its larger size favors greater service life. Chromel-alumel* wires, proven to be the most durable, are used exclusively. However, installing the wires in a reducing atmosphere shortens service life.

In atmospheres up to 800 F, asbestos insulation is adequate, while above that temperature, porcelain insulators are sufficient to protect the thermocouple wires from contamination. However, if the wires are not protected, contamination progresses and the wires absorb and combine with materials in the flue gas, particularly sulfur, and the temperature-emf relationship is altered.

*Trade-Mark registered, Hoskins Corp.

W. T. Elliott,
Power Plant Supt.,
says...



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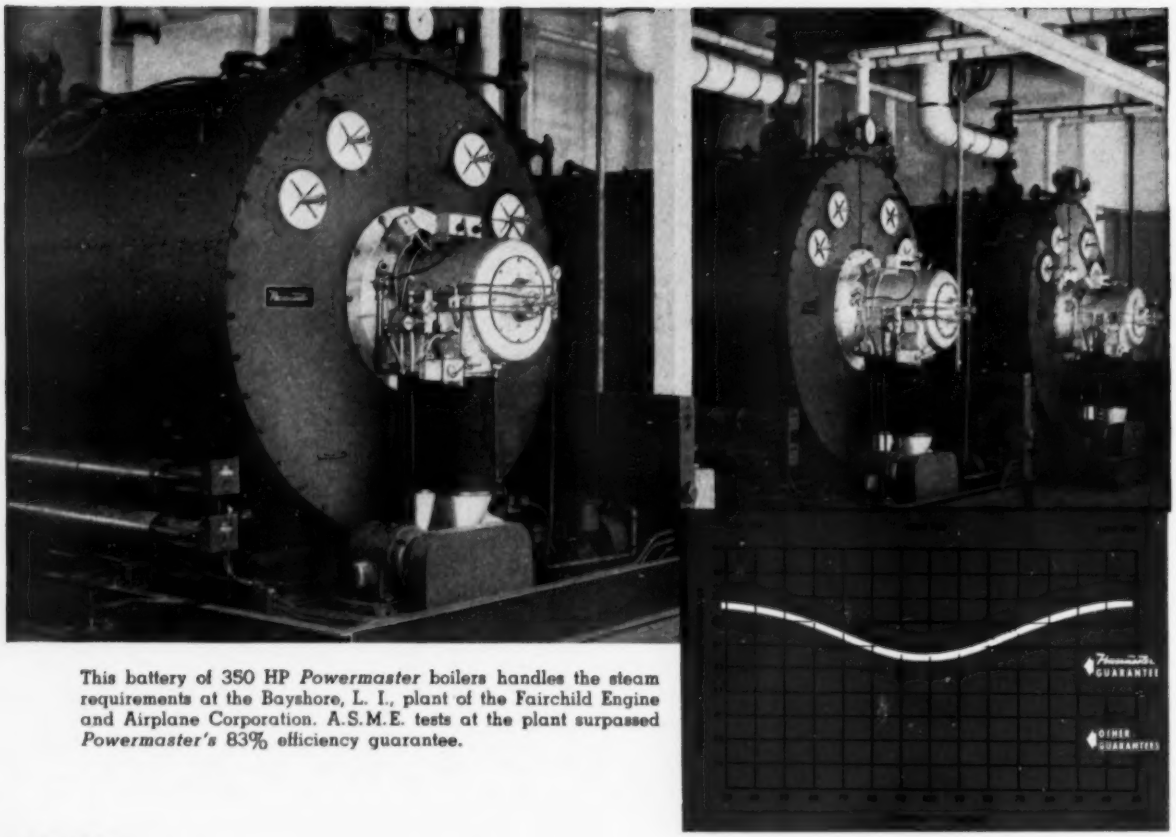

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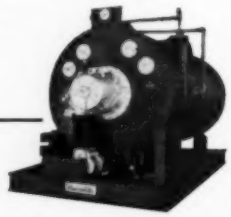

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Selection and Application of Cables . . . . . for Use in Ducts

A WIDE VARIETY of cables is used in ducts for power transmission and distribution, communication, signalling, control and other purposes. Great diversity of constructions results but, regardless of purpose and construction, all must withstand exposures in ducts below ground.

Some of the most common exposures are:

1. Moisture.
2. Continuous submersion.
3. Corrosion of lead sheath in the presence of acids, alkalies, fumes, gases, and other corrosive agents.
4. Rotting of braids and other fibrous coverings.
5. Hot spots due to proximity of steam lines, flame, and other sources of heat.
6. Electrolysis.
7. Cable movement in ducts and manholes.
8. Impact, vibration and other mechanical damage.

Duct cables are chosen first as to type of insulation, which depends on size of load, length of line, voltage, maximum operating temperature and economics. Over the insulation, the sheath and/or protective covering is applied.

Fortunately, cables and cable materials of economical design are available for protection against practically all the above exposures. Insulations commonly used are listed in Table 1.

Except for certain rubber insulated, moisture resistant compounds and thermoplastic compounds, cables in underground ducts require lead sheath unless ducts are permanently dry. Types of lead sheath and their uses are given in Table 2.

If the ducts are fairly dry or ground waters are not harmful, the lead sheath is sufficient. Probably 95 per cent of all high, medium and low voltage *leaded* cables in ducts are plain lead sheathed, though use of protected lead sheath is increasing. If harmful waters are present or electrolysis and corrosion must be combated, protective coverings are applied over the lead depending upon conditions or exposures, such as given at left, which may be encountered. See manufacturers' literature and other articles in this series for more detailed descriptions of coverings.

Large Single Conductor Cables

In most cases, even in dry ducts, single conductor, concentric lay, annular and segmental stranded, lead covered cables of approximately 250,000 cir mils and larger should be operated with open circuit sheath (and armor when used) especially when installed with one cable per duct. This arrangement allows the sheath to be grounded at one point only in order that sheath and armor currents may be reduced and nominal current carrying capacity retained. Sheath voltage to ground should not exceed 12 v a-c. This limit should prevent electrolysis as well as a dangerous rise of sheath voltage during short circuit. If cables are long and normal sheath voltage might rise above 12 v, sheath insulators may be used.

Where sheath cannot be operated on open circuit, a suitable grounding and bonding method may be employed to reduce sheath and armor currents. In such cases, current carrying of the cable capacity should be reduced slightly to allow for heating by induced sheath currents. For more information on this subject, consult the manufacturers' data available.

Protective Coverings

Nonleaded cables have various protective coverings and armors, depending on the exposure, which should have moisture resistance in addition to other characteristics. For example, insulated cables for networks in ducts may be covered with plain lead, neoprene

Abstracted by courtesy of Anaconda Wire and Cable Co. from general Catalog No. C-79. Because of its wide general interest, this material was selected from the catalog, which gives detailed information on all common cables including types not made by the company. This is the third of a series of articles on various types.

TABLE 1 — CABLE INSULATIONS USED IN DUCTS

Insulation	Applications
Paper	Power transmission and distribution, a-c networks, low voltage d-c networks
Varnished cambric	Power distribution, networks, control, signal control and power
Rubber	Power distribution, networks, control, signal control and power
Thermoplastic	Power distribution and control, high frequency power, communication

TABLE 2 — TYPES OF LEAD SHEATH

Type	Specifications	Use
Plain lead	ASTM B29	General use
Copper-lead	ASTM B29	General use. Better for fatigue, corrosion, bending, vibration
2% tin-lead alloy		Aerial, shipboard and other cables only when specified. Greater resistance to fatigue, corrosion, abrasion, vibration and internal pressure
Special alloys*		General use when alloy lead is specified. Highest resistance to radial creep, longitudinal bending, vibration, internal pressure and age-hardening. Best for all paper insulated cables, especially those with heavy daily load cycles, and for aerial cables, risers and cables on slopes

*Such as Anaconda F-3 arsenical lead alloy.

jacket or tape and braid. Under more severe ground conditions, neoprene nonmetallic covering, which is resistant to almost every duct exposure, may be used. This has good protection against impact and abrasion if such may be found in ducts. Mechanical damage, however, is not a common exposure in ducts.

Cables for combined duct, conduit and aerial installations are frequently used as in traffic control, railroad signalling, power distribution and other applications. In such cases, of course, the cable must withstand exposures met in all three types of installation. These would include, besides those already mentioned, condensation in conduits, uneven voltage stress distribution in the cable (unless it is shielded,) weathering and sunlight. Nonmetallic armored cables for such use include rubber and plastic insulated power cable, and thermoplastic jacketed and neoprene jacketed types. Of course, lead sheathed cables with or without protective coverings and armor as may be required are also used.

. . . for Buried Circuits

CHIEF PURPOSE of buried cables is to provide a reliable installation when cables in ducts are unjustified for reasons of economy, nature of the ground or other reasons. For extensions from aerial lines, from duct systems, or as complete systems or parts of industrial distribution, they are economical and suitable for a great many applications.

Types of Buried Cables

Of the more common types, listed herein, each usually has one or more applications for which it is best suited for reasons of economy, the kind of exposures to be met and the voltage and load to be carried. Some constructions may be used for a variety of applications. Full descriptions are given in manufacturers' literature.

Parkway Cable

Parkway cable (for direct burial) is the name applied to a leaded type with an outer protective covering of jute plus metallic armor and more jute. The cable conductors may be insulated with paper, varnished cambric or rubber. The armor may be two flat steel tapes (galvanized or plain) or interlocked steel or bronze tape. This construction provides very good mechanical protection for direct burial. Generally, it is used for voltages up to 15 kv, but in some cases to 35 kv and 46 kv. For higher voltages, other types of installation, either aerial or in ducts, may be justified.

Parkway cable may be used for protection against some chemicals, such as gasoline, oils and greases (as encountered in the ground) but not for chemicals such as acids and alkalies, which might start corrosion of the metal tapes or lead sheath. The asphaltic type saturant will protect the tapes to a high degree but strong corrosive agents may shorten life of coverings and cable. The cable is protected by the lead sheath in moist or wet ground. On the whole, principal purpose of parkway covering is protection against mechanical damage.

Neoprene Jacketed Type

This cable for buried service is widely used where parkway covering is unnecessary or unsuitable—as when great mechanical protection is not required, when soil conditions might result in corrosion of the metal, or when a lighter weight cable is desired. The cable core is nonleaded and the type of insulation is limited to rubber compounds.

In a well known type of neoprene jacketed cable, conductors are insulated with a suitable rubber compound, interstices filled with heat conducting rubber fillers and the core covered with a neoprene jacket.

This type has most of the advantages sought for buried cables including high resistance to moisture, chemicals, sunlight, organic decay, abrasion and mechanical damage (neoprene jacket is preferable against chemicals and sunlight). Corrosion and electrolysis are eliminated. Flexibility, light weight and ease of handling facilitate installation and reduce cost. No outer covering is required. It can be used for buried, duct or aerial service, or for a combination of these.

For these reasons, buried power and control cables often are the neoprene jacketed type, suitable for those applications where high reliability is desired. Applications include signal and control systems, underground primary and distribution systems, and combined underground and aerial distribution. By adding over the neoprene jacket a saturated sisal braid, with coatings of asphaltic compound under and over the sisal, additional protection is obtained for special purposes.

Thermoplastic Jacketed

A thermoplastic jacket having wide use in this category is PVC (polyvinyl chloride). Construction is similar to neoprene jacketed cable. Insulation is usually a thermoplastic.

Outstanding features of this jacket are its high resistance to moisture, sunlight, acids, alkalies and most oils, and its high abrasion resistance. It also possesses the other characteristics listed for rubber jacketed cable. No outer covering is required for cables having a thermoplastic jacket.

Neoprene Hose Type Jacket

This covering is used to protect both nonleaded and lead covered cables. It consists of two or more layers of neoprene and cloth reinforced neoprene tape applied directly over the cable core or sheath and vulcanized. Thickness of the jacket depends on mechanical requirements and severity of the deteriorating agents which may be found. Each tape is approximately 1/32 in. thick.

Since the material of the tapes is principally neoprene, the jacket has much the same characteristics as the neoprene jacketed type—such as high resistance to moisture, acids, alkalies, sunlight, organic decay, and abrasion. It is not considered as good against mechanical damages as an extruded neoprene or PVC jacket. Therefore it is installed preferably where such action is not too severe or where additional external protection may be needed for full mechanical protection. The lead sheath is protected from attack by corrosion and electrolysis, and lead covered cables may be installed where otherwise impossible. As with an extruded neoprene jacket, corrosion and electrolysis are eliminated. Best applications for hose type jackets are where no hygroscopic material is immediately underneath the cable.

Fibrous Coverings

Besides hose type jackets for lead covered cables, other nonmetallic coverings are used for lead sheath protection. Principal and most suitable is one or two jute servings. This covering is less effective than the parkway type and therefore should be used where protection against mechanical damage is required to a lesser degree. Protection against corrosion and electrolysis is less than with a hose type or extruded jacket. Jute braid is preferable to jute serving for aerial service.

Sisal braid is also excellent as a fibrous covering for lead covered, buried cables, subject to the same limitations as jute serving. However, it can be used for buried, duct and aerial service, or a combination of these. Jute and sisal are used only to a limited extent today, in favor of neoprene or hose type jackets.

NO SEAT TO SCORE, WEAR,
CLOG OR LEAK • O SEAT TO
OR LEAK •
NO TO SCORE, WEAR,
CLO EAK • NO SEAT TO
SC R, CLOG OR LEAK •
NO SCORE, WEAR,
CLO • NO SEAT TO
SCOR AR, CLOG OR LEAK •

● *Yarway Seatless Blow-Off Valve showing balanced sliding plunger in closed position. For pressures to 400 psi. Available singly or in tandem, angle or straightway.*

BEHIND IT... *AN ENGINEERING REASON*

More than 16,000 boiler plants use Yarway Blow-Off Valves. Why?

Because behind each valve is an engineering reason.

Take the Yarway Seatless Blow-Off Valve for low and medium pressure boilers. *It has no seat to score, wear, clog or leak.* The unique balanced sliding plunger eliminates a common source of blow-down valve trouble. Many boiler shut-downs are saved... power interruptions avoided and... production speeded.

Specify Yarway Blow-Off Valves on your boilers—*including package units.* You'll be rewarded by dependable, trouble-free blow-down service.

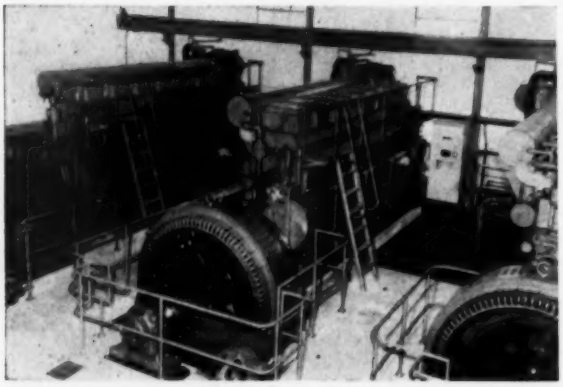
Write for Yarway Blow-Off Valve Bulletin B-425 (pressures to 400 psi) or Bulletin B-433 (pressures to 2500 psi).

YARNALL-WARING COMPANY
109 Mermaid Avenue • Philadelphia 18, Pa.

YARWAY | blow-off valves

spot news

of what's happening in U. S. industrial plants



Tarboro Cuts Costs With Heavy Fuel Oil

Substantial savings have been reported by Tarboro, N.C., municipal power plant, as a result of using No. 5 fuel oil in three diesel-generator units, instead of the more expensive light diesel fuel.

In 1949, when Tarboro added a new wing to its power plant, three 1760 hp, 16 x 20 in., four-cycle, supercharged Worthington diesels, each developing rated horsepower at 360 rpm, were installed. These units now carry 80% of the total load. The high cost of diesel fuel led officials and engineering consultants to select engines capable of burning cheaper, heavier oil, and to design a fuel system for efficient handling of the heavy fuel. Fuel now in use has an API gravity of 15.5; viscosity S.U. 250 at 100 F; sulphur 1.59; and ash .04.

Because heavy fuels are not sufficiently volatile to enable their use for engine starting and warming up, a dual fuel system has been necessary. Providing light oil for starting purposes, this system also insures reliable operation regardless of auxiliary equipment failure or the unavailability of any given type of fuel oil. The system is highly flexible, permitting use of either of the two fuels, or any combination of the two. Actually, there are two complete fuel oil systems which merge at the engine selection valves. By setting these valves, the engines can be run off either system.

Use of heavy fuel oil has admittedly presented problems over and above those encountered with normal fuel. Higher solids content imposes additional filtration problems, and also places a heavy load on the injector pumps. Cylinder liner wear is also somewhat increased.

Many of these problems have been solved by centrifuging, and by using both edge type and cotton type filters on the fuel oil. Chromium plated piston rings, now almost standard in automotive practice, are used in the top two grooves of each piston in one engine. They show excellent promise of maintaining compression and reducing oil consumption for long periods, and their use may be extended to the other two engines.

In the last fiscal year, the new units generated approximately 84 per cent of their total production on heavy oil—the rest on light oil. Fuel cost per kw hr was 5.1 mils on heavy oil, compared with 8.5 mils for the same engines on light oil. Thus, the use of No. 5 fuel resulted in a saving of 3.4 mils per kw hr. The current price differential between the two fuels is 4.1¢ per gal.

The Cover--General Electric Co.

The cover this month is a photograph of the General Electric turbine-generator at the Municipal Power Plant, Wyandotte, Mich. This is a straight condensing machine operating at 825 F and rated at 11,500 kw. It exhausts at 1½ in. Hg absolute.

Inserted is a photograph of a high pressure, closed feedwater heater used in the Wyandotte station. It was manufactured by Ross Heater & Mfg. Co., and has a capacity of 350 gpm, with water entering at 250 F from the deaerator and leaving at 300 - 350 F, according to load on the turbine-generator.

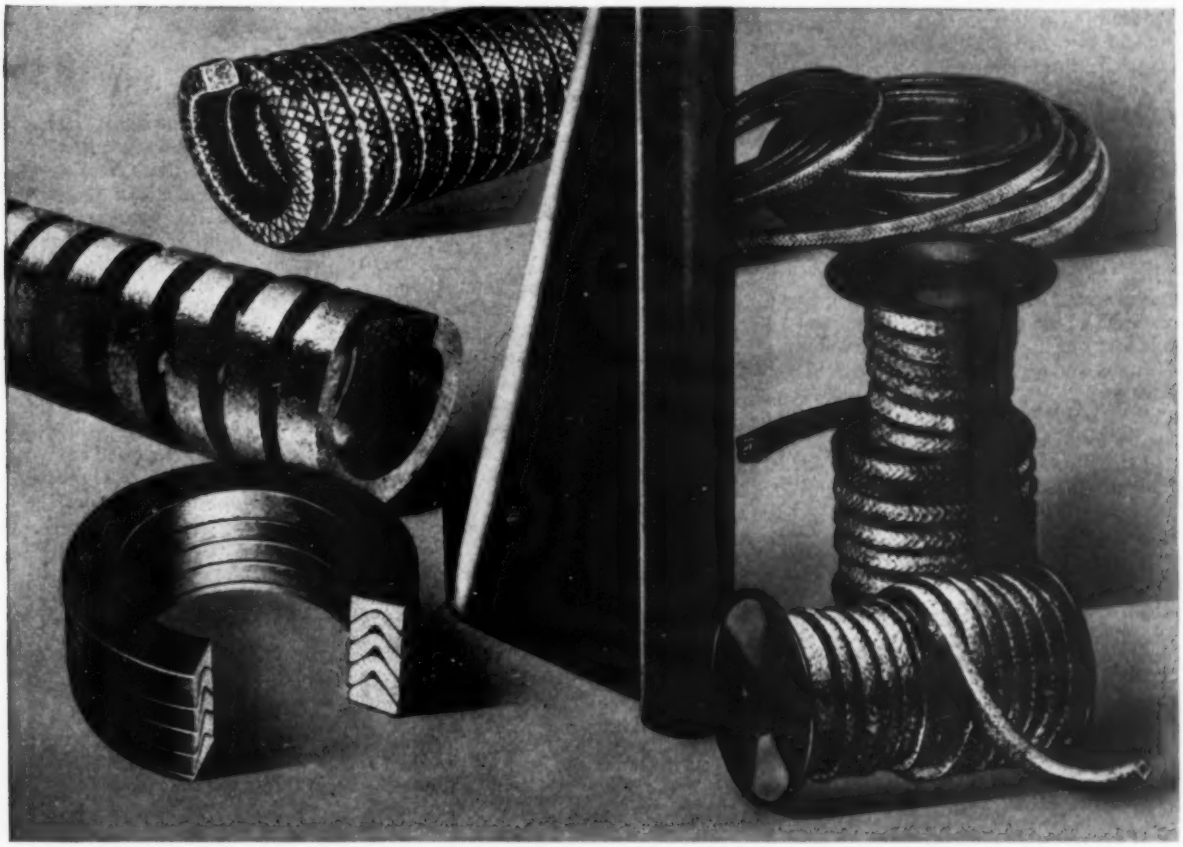
Paper Manufacturer Uses Saw To Solve Floor Maintenance Problem

Consolidated Water Power & Paper Co., is confronted with frequent floor patching and maintenance, due to heavy wheel traffic in its six Wisconsin plants. The company reports important savings have been affected by sawing worn and damaged areas in concrete floors, before breaking.

Perimeter of a damaged area is sawed ¼ of the slab depth to provide a perfect plane of weakness for faster, neater air-hammer breakout. Breakout fracturing is confined within the sawed area, leaving the surrounding area free of hidden

(Continued on page 90)

NOW! 95% OF ALL PACKING NEEDS ARE MET WITH R/M's BIG 7



Lower inventories! Simplify ordering! Reduce downtime!

Don't labor any longer under the impression that you must carry 10, 20, 50 different types of packing. The whole idea is *obsolete* as of now! Unless you have a very rare packing application, just 3 or 4 of R/M's new "Big 7" Packing Types will probably meet every one of your requirements. Nothing less than an engineering feat—from raw materials through continuous manufacturing processes—has made this simplified approach to the packing problem possible. To accomplish it, R/M has drawn to the fullest extent on its 50 years of know-how and experience. It has utilized the research, testing and production facilities of all its seven great plants. You can count on these "Big 7" R/M Packing Types for superior performance every time. See your distributor for details. Let him show you how R/M Packings will lower your inventories, simplify your ordering, reduce your downtime.

R/M **PACKINGS**
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings • Teflon Products • Asbestos Textiles • Industrial Rubber Products • Abrasive and Diamond Wheels Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Sintered Metal Products • Bowling Balls

(Continued from page 88)

fractures. The smooth, straight shoulders of the patch eliminate the necessity of feathering, and a perfectly smooth surface remains after replacing. Since the patch is cut to exact size, there is often a saving in replacement material.

According to the manufacturer, Clipper Manufacturing Co., the saw also can be used to reduce costs of trenches for utility lines, air lines, sewer lines, and conduit. Only a minimum area need be sawed, and the smooth, spall-free replacement patch is said to require no future maintenance.

Engineer Predicts Demineralization for High Pressure Boiler Feedwater

Experience and research in efficient boiler operation at high pressures has indicated the importance of maintaining low levels of silica content in boiler salines. In a paper presented before the American Power Conference in Chicago, M. E. Gilwood, Director of Research, The Permutit Company, stated, "Higher silica levels result in solution of silica in the steam and subsequent deposition of silica on the turbine blades in the low pressure stages of the turbine."

In the near future, the author predicted that maximum permissible silica content will be less than 1 ppm for pressures of 1800 to 2400 psi, and higher. "Since the make-up water is concentrated many times in the boiler, it has become common practice to specify that the treated make-up water should contain no more than 0.1 ppm of silica."

Mixed bed and two-step demineralization by ion exchange are two processes that can be used to reduce dissolved silica and solids to meet the exacting specifications of high pressure boiler feedwater. According to Gilwood, dissolved silica can be reduced to levels approaching 0.01 ppm.

Instrument for Measuring Smoke Density Aids Air Pollution Studies

Greater interest in the prevention of air pollution has increased the need to observe the density of smoke issuing from stacks. A new instrument, known as the smokescope, has been developed by Mine Safety Appliances Co. to eliminate the causes of error inherent in the methods presently used for measuring smoke density. This instrument was described in a paper presented on April 28, at the Spring Meeting of the American Society of Mechanical Engineers in Columbus, Ohio.

Estimation of smoke density is usually made by visual comparison with shaded standards of a Ringleman chart. The trouble with this method, according to the paper, is that the observer must take variations in the lighting and background against which the smoke is viewed into account, as well as the illumination of the chart.

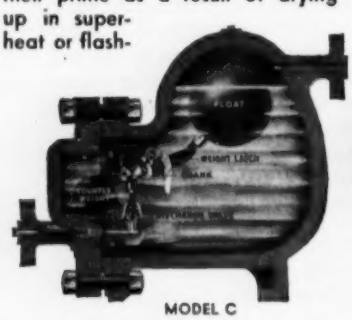
In the smokescope, a reference film disc is viewed against the background adjacent to the stack in order to eliminate the effect of differences in lighting. In this manner the

(Continued on page 92)

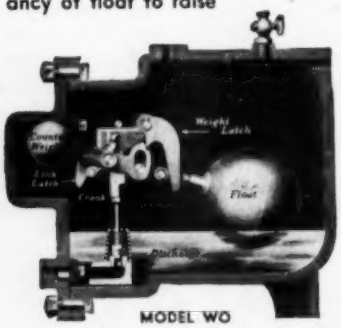
Nicholson Weight-Operated Traps

NEVER NEED PRIME

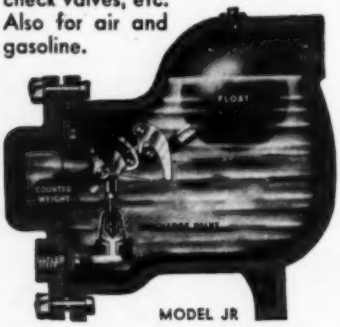
Nicholson weight-operated traps, under no condition, leak live steam. This prevents the costly loss of steam occurring when bucket traps lose their prime as a result of drying up in superheat or flashing at sudden pressure drops. Under these conditions Nicholson weight-operated traps still hold tight because they do not depend on buoyancy of float to raise valve. For steam purifiers, superheated lines, headers, separators, heaters, dry kilns, pipe coils, turbine throttle valve drips, stop and check valves, etc. Also for air and gasoline.



MODEL C



MODEL WO



MODEL JR

3 TYPES—press. to 200, 500 and 1500 lbs.; for every large-capacity, heavy-duty use.

CATALOG 751

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

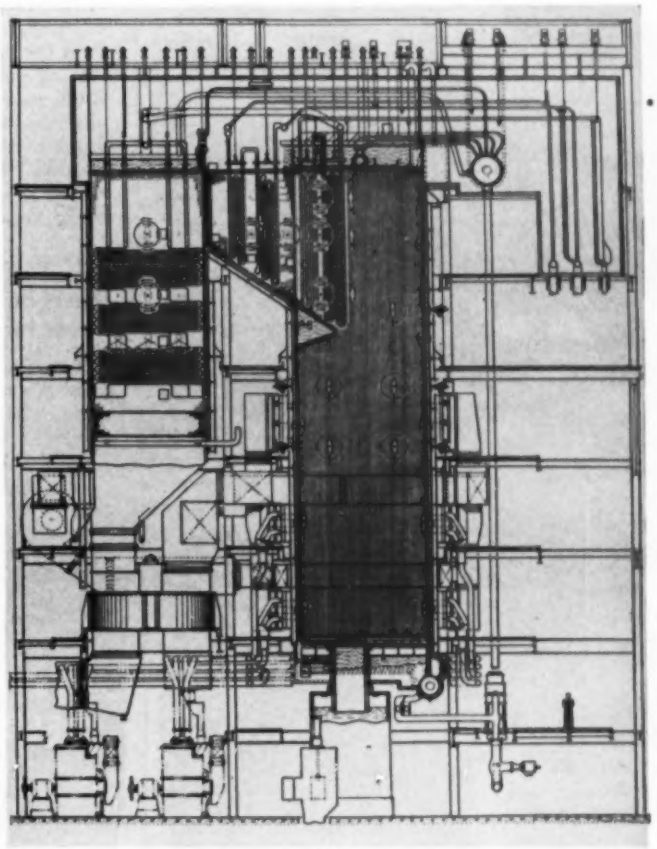
135 OREGON ST., WILKES-BARRE, PA.

Representatives in 58 Key Cities to Help You Solve Specification and Maintenance Problems in Traps, Floats, Control Valves

A DIAMOND Cleaning System

for Highest Steam Temperature Yet!!!

Kearny Goes to 1100° F Steam Temperature *plus reheat*



For this most important unit, a DIAMOND CLEANING SYSTEM has been selected to assure optimum efficiency and continuity of operation. High superheat and reheat temperatures must have *positive* and *uniform* cleaning to assure *safe* metal temperatures. Diamond equipment and experience meet this requirement in every respect: economy, reliability, and serviceability.

Kearny Generating Station
PUBLIC SERVICE ELECTRIC AND GAS COMPANY

50th ANNIVERSARY 1903-1953

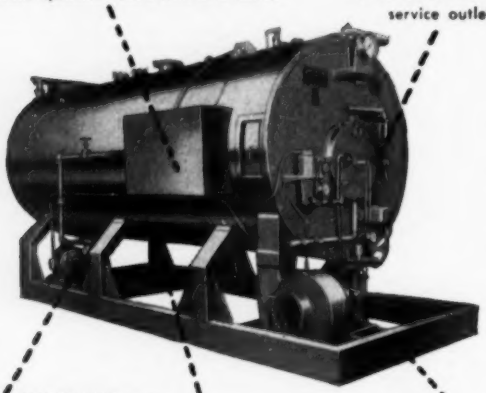
DIAMOND POWER SPECIALTY CORPORATION
LANCASTER, OHIO
Diamond Specialty Limited • Windsor, Ontario

6160

Here's Why...
AMESTEAM GENERATOR
Cuts Your STEAM COSTS

EYE-LEVEL CONTROLS and full automatic operation save time and labor.

FULLY PIPED AND WIRED — needs only to be connected to service outlets.



COMPLETE UNIT with feed water pump, fan, condensate tank, refractories, insulation. Needs no expensive stack or brickwork!

EVERYTHING EASY TO GET AT! Look at the space underneath the shell!

REQUIRES NO SPECIAL FOUNDATION! Just set unit on boiler room floor.

HERE'S EASY CLEANING!

Rear flue cover and one-piece rear baffle are easily opened on davit-type hinges to expose furnace and all tubes — and there are ample clean-out doors in front end.

IF YOU WANT LOWER STEAM COSTS look into these compact units of 80% guaranteed efficiency. Write now for Bulletin 1050. 20 sizes, 10 to 600 h.p., 15 to 200#, to burn oil or gas. WRITE TODAY!

AMES IRON WORKS INC.
BOX G-53 OSWEGO, N. Y.
Builders of Better Boilers since 1848

spot news

(Continued from page 90)

smoke and the reference film receive light from the same source, thus density estimations are not affected by background variations or by brightness of the day.

To further improve the accuracy with which estimations can be made, a lens is used to project a virtual image of the reference standard to a focal distance equivalent to that of the stack. This makes it unnecessary to refocus the eye while making a comparison.

In the smokescope, the stack is viewed through three aligned apertures in a closed, tubelike section. The apertures limit the field of vision to the area of the stack, thus preventing entrance of stray light. The aperture nearest the eye is the unsilvered center spot of a mirror. On the remainder of this mirror is reflected, by means of a mirror and lens, an image of the film showing the shades for various densities of smoke. The eye therefore observes the smoke surrounded by the reference film for comparison, without needing to change focus.

Diesel Provides Intermittent Power for Transferring Grain

Recent refinements in the design of diesels are reported to make this type of engine as easy to start as an automobile engine. With this added advantage, diesels can now be

(Continued on page 95)

Atlantic Flexible Metal Hose Offers

FREEDOM FROM BREAKDOWNS

due to VIBRATION, MISALIGNMENT, EXPANSION, CONTRACTION.

—and is better for conveying steam, gases, molten chemicals, oils, refrigerants, tars, asphalt, alkalies, gasoline, light or semi-solids. Seamless or interlocking construction in steel, stainless steel, bronze, 1/8"—36" I.D. with appropriate fittings.

Write for Bulletin 500. See our Catalogs in Sweet's Files for Product Designers and Mechanical Industries.

Atlantic Metal Hose Co., Inc.
124 W. 64th St., New York 23, N. Y.

ALL FORGED STEEL

Edward
CHECK VALVES

for freedom from vibration, clatter and piping shock

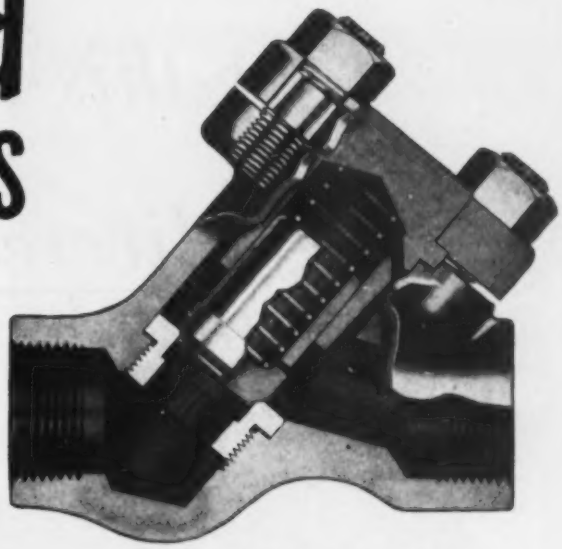


FIG. 4638,5538

For all piping systems requiring small check valves, Edward furnishes a complete line of forged steel valves in both principal check valve types:

PISTON TYPE CHECK VALVES for extra advantage in lines where it is important that the disk closes tightly upon the seat. Careful design of internal parts gives full flow area, low head loss, avoids excessive shock. Exclusive disk guide lip and spring loading for quick positive seating. Available with stellite contact faces on seat and disk on special order.

BALL CHECK VALVES are ideal where heavy viscous fluids are encountered. Bodies are of specially heat treated forged steel. The stainless steel ball of special EValloy high chromium stainless steel is guided by two steel ribs. A spring aids in seating the ball on the carefully lapped seat.

AVAILABLE IN WIDE RANGE OF SIZES AND STYLES

- √ 600, 1500 and 2500 lb sp pressure classes
- √ Horizontal or vertical types
- √ Screwed, flanged or socket welding ends
- √ Union, bolted or welded bonnet
- √ Ball or piston type disk
- √ In ¼", ⅜", ½", ¾", 1", 1¼", 1½" and 2" sizes

GET ALL THESE PLUS FEATURES:

- √ Extra strong and long spring of stainless steel for sure closing action
- √ Rated for 600 lb sp at 850F, 1500 lb sp at 850F and 2500 lb sp at 1000F
- √ Extra strong bodies of specially heat treated forged steel
- √ Cushioned closing action eliminates excessive vibration
- √ Fit any piping arrangement, vertical or horizontal
- √ Corrosion proof stainless steel seats and disks or balls
- √ Accessible removable seats
- √ Easy disassembly if needed
- √ Streamlined body contours for free flow, low pressure drop

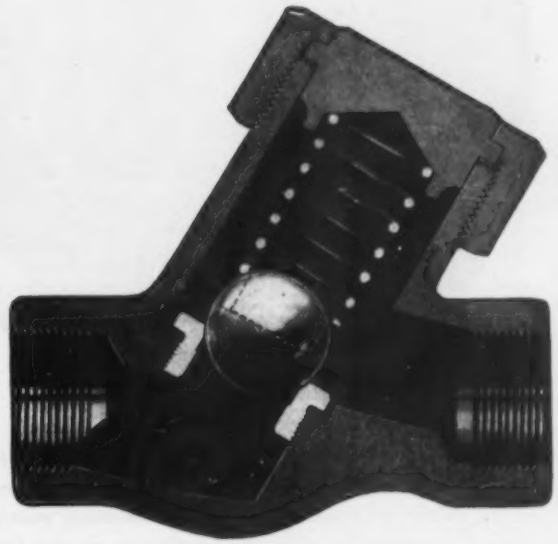


FIG. 2672,3572

In addition to forged steel check valves, Edward builds a complete line of larger cast steel check valves—there is an Edward valve for every check valve application. Write for complete information.

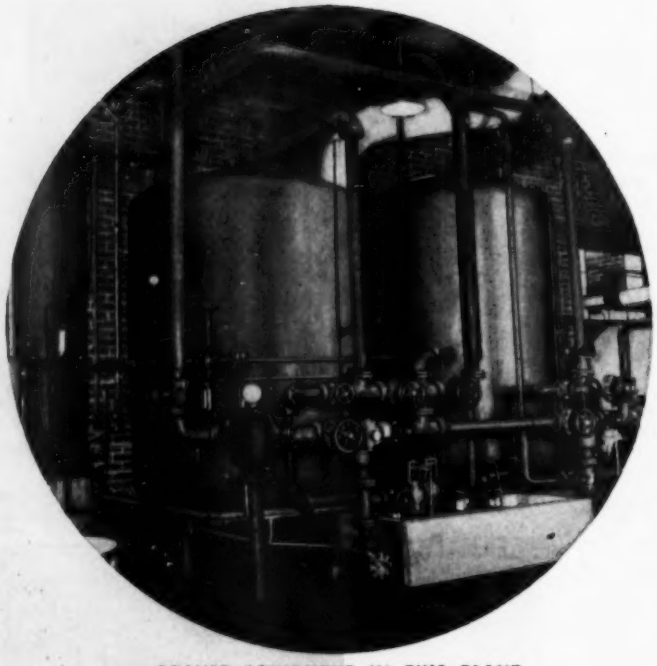
Edward Valves, Inc.

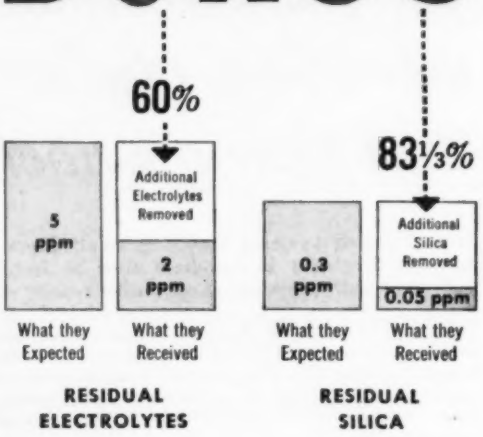
Subsidiary of ROCKWELL MANUFACTURING COMPANY

40 W. 144th St. • East Chicago, Indiana

Another Product

How this Demineralizer delivered a BONUS





GRAVER EQUIPMENT IN THIS PLANT

Two-bed demineralizer to treat 300 gpm of boiler feed make-up. Total capacity of softening plant per regeneration: 640,000 gallons, using Gravex ion exchange material. J. E. Sirrine Co., Consulting Engineers, selected Graver demineralizing equipment.

GRAVER WATER CONDITIONING CO.

Division of Graver Tank & Mfg. Co., Inc.

216 WEST 14th STREET, NEW YORK 11, N. Y., Dept. IP-D

In Canada: The Bird-Archer Co., Ltd., Cobourg, Ontario

In Mexico: Proveedores Tecnicos, S.A., Puebla 259, Mexico 7, D. F.

If you wanted to reduce the total electrolytes in your raw water to *5 ppm*, and the demineralizing plant you installed actually reduced the electrolytes to *less than 2 ppm*, you'd have good reason to consider it a good investment.

And if, in addition, you expected the plant to reduce silica to *0.3 ppm*, and found that the silica was actually being reduced to *less than 0.05 ppm*, you'd have still more reason to consider that your demineralizer was delivering quite a bonus.

That's exactly what happened at the Riegel North Carolina Corporation's plant at Acme, N. C., without increasing the planned regenerant dosage. No wonder both the Company and its consultants consider the results very satisfactory.

To be sure of a completely satisfactory water conditioning plant for your own needs, get the benefit of Graver's 40 years of specialized experience.

GRAVER Demineralizers

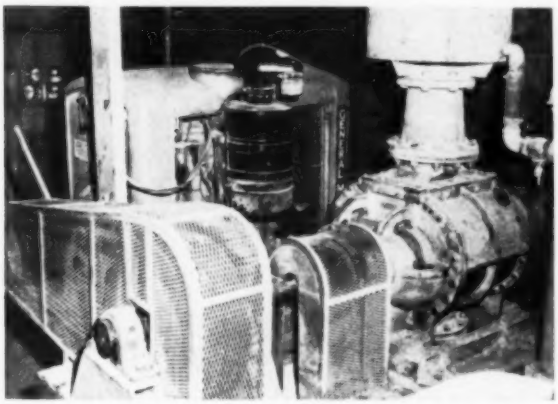
GW 488

spot news

(Continued from page 92)

profitably used in many intermittent applications.

An interesting example is found in the application of diesel power for transferring grain from boats to railroad cars at the Southern States Cooperative, Baltimore, Md. For economy, a General Motors diesel has been installed in a

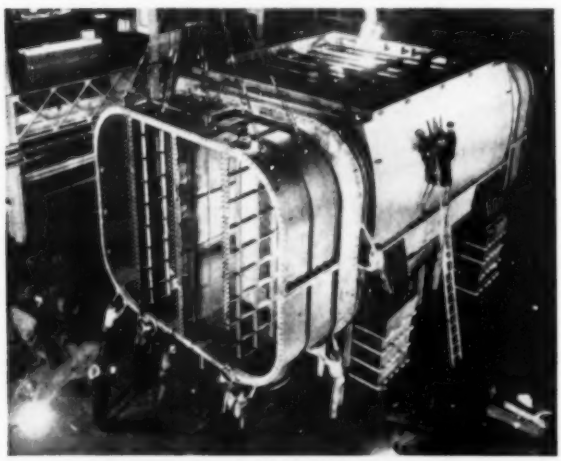


Diesel and suction pump, located in one of Southern States Cooperative's dock buildings, require little space.

Fuller Airveyor system, which consists of a Roots-type exhauster or suction pump and necessary 6 in. piping from the docks to the cars. Sufficient vacuum is created by the exhauster to unload as much as 600 bu per hr of grain.

As boats arrive, the transferring operation is promptly started by push button. When the process is completed, the diesel can be stopped without fear of difficult or time-consuming re-starting when the next boat comes in.

(Continued on page 96)



UTILITY TO GET LARGE CONDENSER

World's largest steam condenser is shown under construction at Worthington Corporation's Harrison, N. J. Works. This 125,000 sq ft unit will serve a 180,000 kw turbine-generator at Consolidated Edison's New York East River Station.

CYCLOTHERM*
CYCLONIC COMBUSTION
PRODUCES MORE STEAM...
IN LESS SPACE...
AT LOWER COST!

- In multiple installations or as a single unit, a Cyclotherm steam generator is your assurance of quick, dependable steam—plus greater all-round economy.
- You get more power . . . Cyclotherm Cyclonic Combustion flame control required just 3 sq. ft. of heating space per Boiler Horsepower. This means your Cyclotherm delivers 66⅔% *more* steam generating power per sq. ft. than ordinary steam generators of comparable size.
- Cyclotherm steam generators can be conveniently located in any building where steam is required. With only 3 sq. ft. per Boiler Horsepower your Cyclotherm saves up to ⅓ the space of conventional steam generators. Installation is easier because each Cyclotherm arrives complete . . . connect fuel, electricity, water and a simple flue and it's ready to generate steam. Controls are fully automatic.
- A guaranteed *minimum* efficiency of 80% saves on fuel—gas, oil or combination—and lowers maintenance costs. Cyclotherm gives you full power from a cold start in 15 to 20 minutes. In multiple installations, an automatic battery control panel distributes the load for maximum operating economy.
- Cyclotherm steam generators are designed for 18 to 500 h.p., 15 to 200 psi operating pressures. Approved —ASME, National Board Standard, and Underwriters Laboratories, Inc.

*Reg. trade name

Find out how Cyclotherm Cyclonic Combustion will fill your steam requirements. Write for a free illustrated folder. Dept. 38

CYCLOTHERM* STEAM GENERATORS

PROFIT by the EXPERIENCE of America's FINEST PLANTS

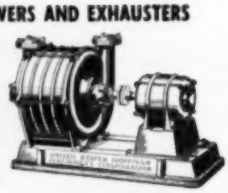
They REPEAT-ORDER
HOFFMAN *Heavy-Duty*
VACUUM CLEANING EQUIPMENT for Wider Range Dust Removal!

One installation sells another, as plant after plant finds that Hoffman vacuum cleaning units save labor—salvage material—reduce product defects—eliminate dust hazards. They've proved that they can clean larger areas of walls, floors and overhead surface with Hoffman equipment. Built to provide bigger capacity, higher vacuum and long years of service on the most grueling plant cleaning jobs.

YOUR CHOICE OF 4 BIG-CAPACITY PORTABLES
Advanced design and construction features for fast, efficient cleaning, with one-man handling. 1½, 3, 5, and 7½ H.P. models to match your specific cleaning requirements

STATIONARY SYSTEMS IN A WIDE RANGE OF SIZES TO FIT YOUR MAINTENANCE OR PRODUCTION OPERATIONS
Provides cleaning in several areas at the same time. Sweepers attach cleaning hose to conveniently located inlets (in a permanently piped system). Dust is removed pneumatically to central collectors for easy disposal.

MULTISTAGE CENTRIFUGAL BLOWERS AND EXHAUSTERS
For agitation of liquids, combustion, mixing—for all air requirements (including the elimination of compressed air). No internal moving parts. Low power consumption. Adopted as standard in steel plants, textile and ice plants requiring 24-hour continuous service. Wide range of pressures, capacities and vacuum, for air or gas. Tell us your requirements.



AIR APPLIANCE DIVISION U.S. HOFFMAN MACHINERY CORPORATION
NEW YORK 11, N. Y.
CANADIAN [illegible] NEWMARKET, ONT.

spot news

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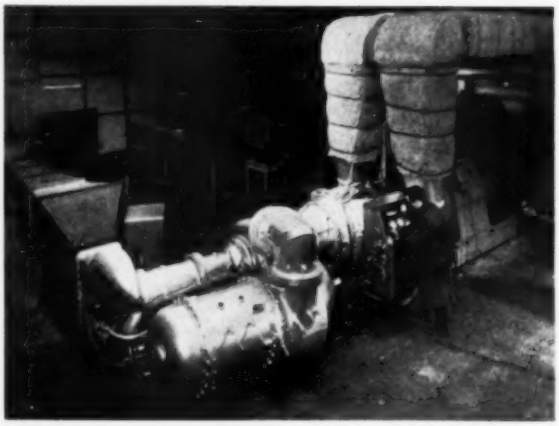


British Gas Turbine Uses Peat as Fuel

Peat, lignite, and low grade coals may soon become an important source of commercial fuel as the result of recent developments in the industrial gas turbine field. Reports coming from England indicate that peat has been successfully used in a gas turbine manufactured by Ruston & Hornsby, Ltd. This development is said to be part of an extensive research program being carried out under the auspices of the Ministry of Fuel.

Preparation of the peat consists of reducing water content, first by a special method of pressing, and then by a drying process using the exhaust heat of the turbine. After drying, it is ground to a very fine powder and subjected to a "fluidizing" process before feeding into the turbine's combustion chamber.

—End

Powdered
ROSIN
Treated to prevent caking
Order thru your jobber or direct
Demand PENICK quality
Penick's ROSIN meets the requirements of a host of industries

●

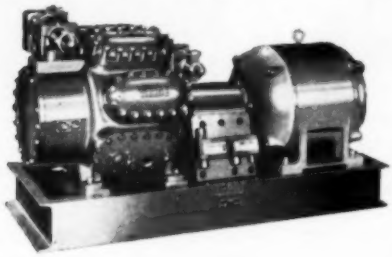
S. B. PENICK & COMPANY

735 W. Division St.
Chicago 10, Ill.
MOhawk 4-5651

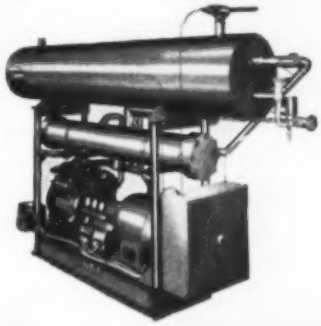
50 Church Street
New York 7, N. Y.
COrtlandt 7-1970

Here's how Trane refrigeration can help solve your production problems

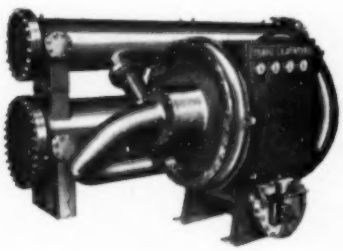
DEHUMIDIFYING and controlling moisture accurately can, as you well know, speed production, improve quality, reduce waste and spoilage. If this is your problem, talk to TRANE. TRANE Reciprocating Compressors, combined with TRANE Climate Changers, control humidity in textile mills, printing plants, storage areas, precision parts finishing and assembly rooms . . . and hundreds of other places. These compressors incorporate the most advanced engineering features. Capacities from 3 to 50 tons.



WATER CHILLING for industrial processes such as electroplating, metal quenching, die cooling, rubber mixing and multi-color printing is now available from a *single* packaged unit . . . the TRANE Cold-Generator. This unit is completely assembled, charged and tested before shipment. Only simple wiring and plumbing connections required. Ten sizes for loads from 10 to 100 tons.



PROCESS AIR CONDITIONING applications in many large plants require water chilling capacities greater than 50 tons. If this is true in your plant, read this: The TRANE CenTraVac, a hermetic centrifugal unit, provides 45 to 200 tons of refrigeration. Self-contained, easily installed, completely automatic . . . the CenTraVac runs without special attention. No shaft seals or gear boxes. Only two main bearings in entire machine.



COMFORT AIR CONDITIONING is needed at many places in modern plants . . . offices, drafting rooms, tabulating machine rooms and other heat-gain areas. It increases employee efficiency, pays dividends in cleanliness too. It's smart to air condition—with TRANE. TRANE Self-Contained units arrive ready to run. Only simple electrical and plumbing connections are required. Six sizes from 3 to 20 tons capacity.

What's your special problem? Whether yours is a simple cooling problem or a complex one . . . whether it's large or small . . . the complete line of TRANE matched air conditioning products contains the right size and type equipment to fit the job. For detailed information, call your nearest TRANE sales engineer, or write to TRANE, La Crosse, Wis.

To solve any comfort or process air conditioning problem . . . talk to **TRANE**

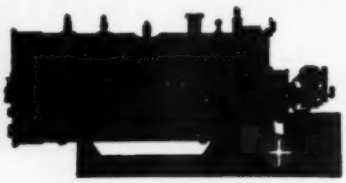
The Trane Company, La Crosse, Wis. • East. Mfg. Div., Scranton, Penn.
Trane Co. of Canada, Ltd., Toronto • 80 U.S. and 14 Canadian Offices

MANUFACTURING ENGINEERS OF HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT

HOW SUPERIOR SOLVES YOUR STEAM PROBLEMS

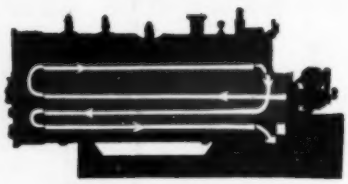
A COMPLETE PACKAGE

Completely factory-assembled and tested, a Superior Steam Generator is backed by undivided responsibility.



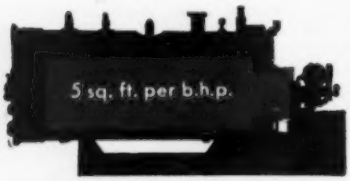
INDUCED DRAFT THAT'S BUILT-IN

...eliminates need of an expensive chimney... Multiple fans draw evenly on all tubes, reducing maintenance.



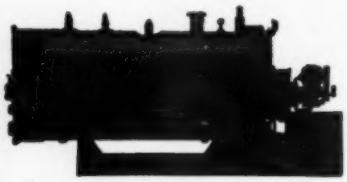
4-PASS, DOWN-DRAFT DESIGN

High gas velocities produce high efficiency. Down-draft design promotes rapid evaporation, quicker steaming.



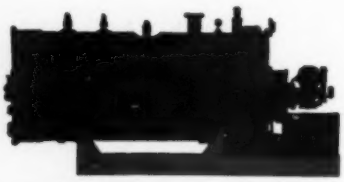
AMPLE HEATING SURFACE

A minimum of 5 sq. ft. of heating surface per boiler horsepower assures maximum efficiency at full rated capacity.



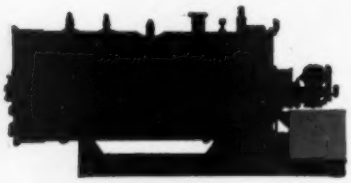
RESERVE CAPACITY

Greater steam space and large evaporating surface provide ample reserve capacity & better than 99% dry steam.



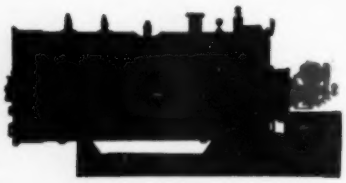
NO EXPENSIVE FOUNDATION

Built on a rigid channel iron base, a Superior Steam Generator needs only a floor capable of supporting its weight.



BUILT-IN CONTROLS

All controls essential to completely automatic operation are factory-wired into an easily accessible control panel.



BURN OIL, GAS, OR BOTH

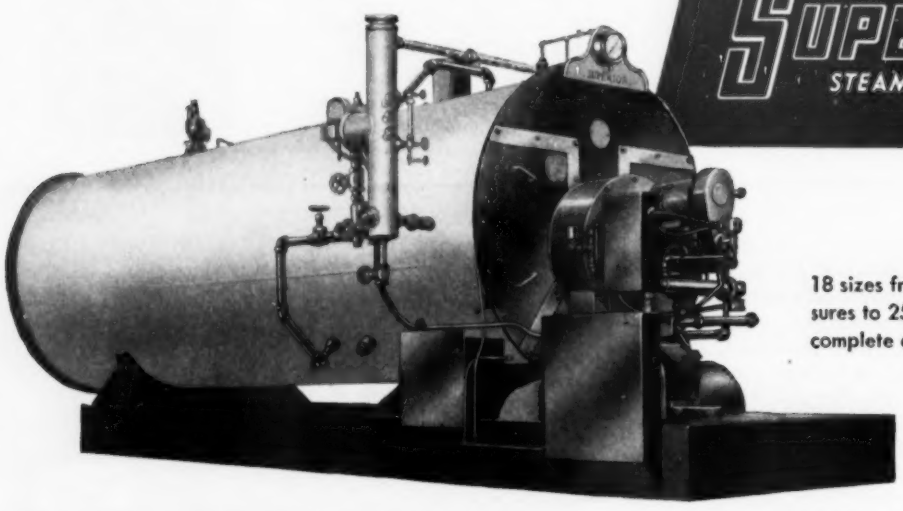
Superior Burners burn oil or gas or a combination of both... changing from one fuel to the other in seconds.

Superior Steam Generators are the ideal choice for a new steam plant... the simplest answer to expanding your present plant... the easiest solution to replacing obsolete boilers.

Guaranteed to develop maximum rated capacities at thermal efficiencies in excess of 80%, their design embodies features which insure long-lived dependability and maximum fuel economy.

for performance you can **BANK** *on*

SUPERIOR
STEAM GENERATORS



18 sizes from 20 to 600 b.h.p. for pressures to 250 p.s.i. or for hot water. For complete details write for Catalog 502.

SUPERIOR COMBUSTION INDUSTRIES INC. TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

3 *special departments featured monthly to give you FREE bulletins, catalogs and product data screened for your personal interest in*

ENGINEERED PLANT SERVICES

1. NEW EQUIPMENT

Begins on page 10

Contains highlights of new products by leading manufacturers, briefed and illustrated for your easy reference. Complete data on each of these products are available ***free***.

2. NEW BULLETINS

Begins on page 116

Includes descriptions of only those bulletins and catalogs that are really ***new*** and of ***direct value*** to you — saves your reading time, yet gives you full service. All bulletins sent to you ***free*** on request.

3. READERS GUIDE TO ADVERTISED PRODUCTS

Begins on page 101

Designed to catalog advertised products for your convenience in finding the ads which are of special interest to you at this time. Also lists those important bulletins, catalogs and working data offered ***free*** in the advertisements.

REQUEST CARD FOR LITERATURE OR MORE INFORMATION—May, 1953

To: INDUSTRY AND POWER, St. Joseph, Mich. Please have forwarded to me, at no obligation, the literature I've indicated by the following key numbers:

New Equipment begins Page 10	*New Bulletins begins Page 116*	*Advertised Products begins Page 101*
No's	No's	No's

Your Name _____ **Title** _____

Your Company _____

Co. Address (St. & No.) _____

City _____ **State** _____

Inquiries for items in this issue not serviced beyond September 1, 1953

FIRST CLASS
PERMIT No. 19
(Sec. 34.9, P.L.&R.)
ST. JOSEPH, MICH.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

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Co. Address (St. & No.) _____

City _____ State _____

Inquiries for items in this issue not serviced beyond September 1, 1953

readers guide

to advertised products

AIR & DUST FILTERS & COLLECTORS

Key No. 500—Bull 500 contains facts on the Cottrell precipitator. Research Corp. p 48.

Aerotec series mechanical-electrical dust collectors are described on p 36. The Thermix Corporation.

Complete details available on metal or woodworking types of unit dust collectors. The Kirk & Blum Mfg. Co. p 103.

Literature available on Norblo automatic bag type dust collection. The Northern Blower Co. p 119.

Key No. 501—Cottrell electrical precipitators are described in Bull C103. Western Precipitation Corp. p 113.

ANTI-CORROSIVE & PROTECTIVE COATINGS

Key No. 502—Adv. p 43 contains coupon for complete information on Rust-Oleum coating. Rust-Oleum Corp.

BOILERS & BOILER ACCESSORIES

Descriptive literature available on Wickes steam generators. The Wickes Boiler Co. p 25.

Key No. 503—Bulletins illustrate and describe typical installations of Vogt steam generating units. Henry Vogt Machine Co. p 44.

Key No. 504—Bull WG-1823 describes Yarway remote liquid level indicators. Yarnall-Waring Co. p 50.

See adv. p 127 for information on chimneys. Consolidated Chimney Co.

Key No. 505—Boiler auxiliaries, from outlet to stack, are described in P-D Bull 4P201. The Thermix Corp. p 32.

Key No. 506—Bull BW 40 contains valuable data on modern baffle-wall constructions. The Engineer Co. p 126.

BUILDING HEATING, VENTILATING, AIR CONDITIONING & REFRIGERATION

Adv. p 97 contains information on Trane matched air conditioning products. The Trane Co.

BUILDING MATERIALS & MAINTENANCE

Key No. 507—Free Repair Handbook describes Smooth-On repairs. Smooth-On Mfg. Co. p 131.

Hoffman heavy-duty vacuum cleaning equipment is described on p 96. U. S. Hoffman Machinery Corp.

Key No. 508—Free sample and data sheet on Fel-Pro C-5 "Hi-Temp" thread compound. Felt Products Mfg. Co. p 131.

Key No. 509—Coupon on p 132 offers complete details of trial order plan of floor patch and Handbook of Building Maintenance. Flexrock Co.

COAL, ASH & BULK HANDLING

Adv. p 123 contains data on National pneumatic steam ash removal systems. National Conveyors Co., Inc.

Book 2410 shows latest equipment and system layouts for power plants large and small. Link-Belt Co. p 3.

COMPRESSORS

Key No. 510—Schramm air compressors are described in Cat 5110 A. Schramm Inc. p 106.

Key No. 563—Heavy-duty Type Y compressor is described in Bull 766. Chicago Pneumatic Tool Co. p 109.

CONTROLS, REGULATORS & INSTRUMENTS

Key No. 511—Details available on Liquidometer tank gage. The Liquidometer Corp. p 131.

Key No. 512—Cat Rb24 describes Accritem regulators for water temperature control. The Powers Regulator Co. p 31.

Key No. 513—Bull 100 gives full details on automatic regulating valves. Spence Engineering Co., Inc. p 111.

Key No. 514—Bull 5P describes Mercoid magnet operated mercury switches. Key Co. p 129.

(Continued on page 102)

PRODUCT INDEX

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Building Materials & Maintenance .. 101
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Power Transmission 104
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Packaged Steam Generators 104
Packing & Gaskets 106
Pipe, Tubing & Hose 106
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NOTE—This department is both a product index for advertising and a keyed listing for advertised literature. Refer to advertisement on page indicated and contact advertiser directly—or list paragraph key numbers on reader service card (page 99) to get data you want

Little stories of big savings in LAGONDA tube cleaning

The case of the Insistent Engineer

Happened at an important middle western utility. One of the engineers kept insisting that the water treatment they were using should be supplemented by occasional mechanical tube cleaning, which had not been used for four years. Nobody believed him, but his persistence finally won out to the effect that they consented to clean one boiler with Lagonda tube cleaners, just to see. Result, startling increased efficiency of the unit, an unexpectedly large amount of scale removed, and the scheduling of Lagonda cleaning for all the boilers not only in that plant, but in all other plants of the system. Further result, orchids for the insistent engineer.

Y-2-1

GET BULLETIN Y-29
with details on all types of cutter heads and motors for cleaning all tubes, small, large, curved, straight. On request.

LAGONDA
...the oldest name in tube cleaning!

ELLIOTT COMPANY
LAGONDA DIVISION · SPRINGFIELD, OHIO
Plants at: Jeannette, Pa. • Ridgway, Pa. • Amperic, N. J. • Springfield, O. • Newark, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

readers' guide

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Details are available on the Henszey flow indicator. Henszey Co. p 123.

ELECTRICAL DISTRIBUTION

Key No. 515—Further information on G-E load-center system is described in Bull GEA-3592. General Electric Co. p 16, 17.

Key No. 516—Price list and catalog available on "Economy Delay" Renewable fuses. Economy Fuse and Mfg. Co. p 38.

Key No. 517—Bull 7004-B contains complete details on I-T-E Metal-Clad switchgear. I-T-E Circuit Breaker Co. p 8, 9.

Key No. 518—Catalog gives information on Auto-Lite temperature indicators & recorders. The Electric Auto-Lite Co. p 123.

Key No. 519—Coupon on p 12, 13 offers complete facts on Fusetron dual-element fuses. Bussmann Mfg. Co.

FANS & BLOWERS

Information available on the Wing package draft inducer. L. J. Wing Mfg. Co. p 110.

Key No. 520—Cat 400 gives data and specifications on fans and blowers for every industrial and commercial application. Chelsea Fan & Blower Co. p 132.

FILTERS, STRAINERS & PURIFIERS

Key No. 521—Coupon on p 107 brings you data on Cuno Auto-Klean strainers. Cuno Engineering Corp.

Key No. 522—Catalog sheets 486,481 describe the new Norgren transparent bowl filters. C. A. Norgren Co. p 124.

Adv. p 133 contains information on Sarco pipe line strainers. Sarco Co., Inc.

FUELS & FIRING EQUIPMENT

Key No. 524—Bull CBM contains data on the John Zink Series CBM combination gas and oil burner. John Zink Co. p 47.

Adv. p 27 contains information on Detroit Rotograte stokers. Detroit Stoker Co.

See adv. p 35 for information on bituminous coal. Bituminous Coal Institute.

HEAT EXCHANGER EQUIPMENT

Key No. 525—Bull 120 gives complete information on Niagara Aero heat exchangers. Niagara Blower Co. p 122.

(Continued on page 104)

. . . Type **"M"**

Three models . . . 450, 900 and 1800 CFM capacity . . . cleaned air can be vented to outside or returned to room. Two stage cleaning: centrifugal pre-cleaner and thick steel wool filter pads, easily accessible . . . All-steel construction, nothing to burn.

dust problem?

here's the low cost solution . . .

KIRK AND BLUM unit dust collectors

Where one or several dust-producing machines are operated without a dust collecting system or are too remote from the existing collection system, here's the efficient, trouble-free and low-cost solution. KIRK & BLUM Unit Dust Collectors are compact, easy to install or move, offer exceptional efficiency and capacity.

Both types have many features not found in conventional units, employing rugged material-handling fans and motors from 3/4 to 3 H.P. They are specifically designed for trouble-free operation, easy cleaning and complete dependability.

For complete details, request literature on metal or woodworking types from The KIRK & BLUM MFG. CO., 3174 Forrer Street, Cincinnati 9, Ohio.

. . . Type **"W"**

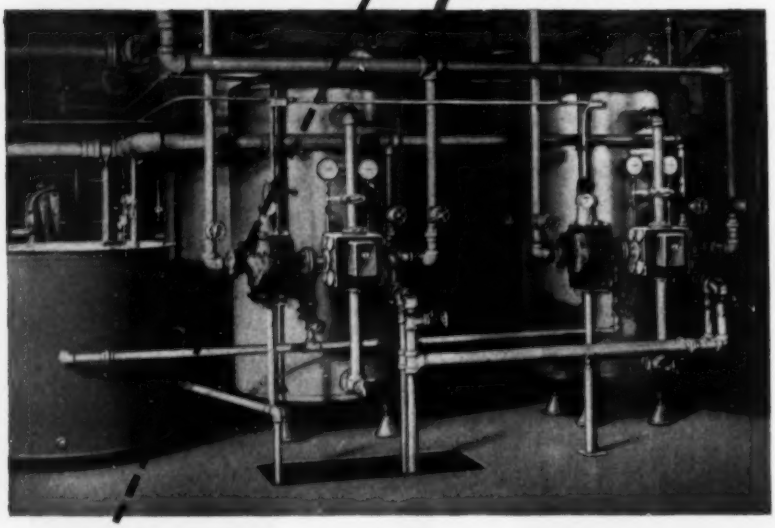
Single model . . . 900 CFM capacity . . . ample for one 6", two 4" or four 3" pipe connections. Heavier particles removed in centrifugal separator, finer particles trapped by semi-automatically cleaned filter bags.

FOR CLEAN AIR . . . THE INVISIBLE TOOL

KIRK AND BLUM

DUST CONTROL

an AMERICAN *process!*



AUTOMATIC ZEOLITE SOFTENING

Assures

continuous supply of soft water

The American Automatic Zeolite Softeners provide a continuous supply of soft water with a minimum of operator attention. Among the advantages of the American System are:

1. Continuous cycle progress indication to provide immediate indication of the condition of each softener including degree of exhaustion.
2. Operator selection of either of three types of operation—automatic, semi-automatic, manual.
3. Complete flexibility so that the cycle may be operated by either automatic, semi-automatic, or manual control with no alteration or additional field adjustment of mechanical components.
4. Absolute valve positioning by means of dynamic braking of the valve operator.
5. Sequence cycle indication during entire regeneration cycle.
6. Control equipment enclosed in a dust proof case with a universal (wall or panel) mounting suitable for location with the softener or remotely located control equipment.

The American Automatic Zeolite Softeners utilize the American CYCLOFLOW Valve—an exclusive American Feature. This valve was specifically developed to provide positive valve action, leak proof operation (an isolating chamber prevents any possible contamination), and positive positioning when controlled by the automatic control components.

The American Automatic Zeolite Softener gives you four position operation with termination of each operation on the basis of that factor controlling the efficiency and effectiveness of the action.

One of the oldest companies in the water conditioning field, American engineers are specialists in the treatment of water for any end use, regardless of the type or source of contamination. They will be glad to assist you in choosing the correct type of equipment for your specific problem. Why not call them today.

SERVICE SINCE 1902 AMERICAN SYSTEM PATENTED TO THE INDUSTRY

AMERICAN *Water Softener* COMPANY

INCORPORATED

FOURTH AND LEHIGH AVENUE • PHILADELPHIA 33, PENNSYLVANIA

DEAERATORS • HOT PROCESS SOFTENERS • REACTORS • FILTERS • ZEOLITE SOFTENERS • CHLORIDE DEIONALIZERS • AERATORS & DEGASIFIERS
HYDROGEN SODIUM ZEOLITE SOFTENERS • DEMINERALIZERS • CHEMICAL FEEDERS • CONTINUOUS BLOWDOWN • SWIMMING POOL EQUIPMENT

readers' guide

(Continued from page 102)

Engineering data available on instantaneous water heaters. Pick Mfg. Co. p 112.

LUBRICANTS, LUBRICATION, OIL FILTERS & PURIFIERS

Key No. 526—"Lubriplate Data Book", a valuable treatise on lubrication. Lubriplate Div., Fiske Brothers Refining Co. p 126.

Adv. p 33 gives information on Stanoil industrial oil. Standard Oil Co.

Texaco Ursa oils are described on p 134. The Texas Co.

Rubilene oil for diesel lubrication is described in adv. p 83. Sinclair Refining Co.

POWER TRANSMISSION

Key No. 527—Catalog and engineering data available on Lovejoy variable speed pulleys. Lovejoy Flexible Coupling Co. p 125.

Key No. 528—Basic Dynamatic units for adjustable speed drive problems are described in Bull GB-1. Dynamatic Corp. p 29.

MOTORS & GENERATORS

Key No. 529—New Bulletin describes the U. S. Varidrive motor. U. S. Electrical Motors Inc. p 129.

PACKAGED STEAM GENERATORS

Key No. 530—Complete details on Superior packaged steam generators are described in Cat 502. Superior Combustion Industries, Inc. p 98.

Key No. 531—Bull VP-13 contains data on C-E Type VP package boilers. Combustion Engineering, Inc. p 4.

Key No. 532—Catalog SB-43D contains data on Erie City's VL unit steam generator. Erie City Iron Works. p 18, 19.

Key No. 533—Cat AD-100 contains complete data on standard size oil, gas, combination oil/gas fired boilers. Cleaver-Brooks Co. p 39.

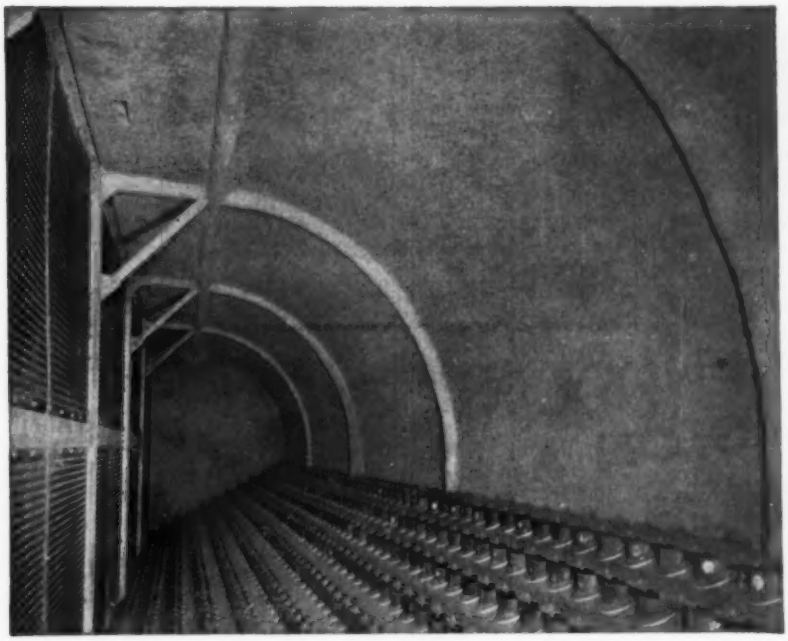
Key No. 534—Bull 1050 describes the Amesteam generator. Ames Iron Works Inc. p 92.

Key No. 535—Bull 2000 contains complete details on Preferred's unit steam generator. Preferred Utilities Mfg. Corp. p 30.

Key No. 536—Free illustrated folder on steam generators, "All Your Questions Are Answered by Cyclotherm" is offered on p 95. Cyclotherm Div., U. S. Radiator Corp.

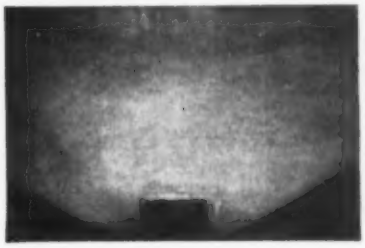
(Continued on page 106)

Industrial concretes made with LUMNITE* can cut costs throughout your plant



TOUGH— Inside view of a giant multiclone dust collector Gunite-lined with Lumnite and trap rock sand at the Sewaren, New Jersey, generating station of the Public Service Electric and Gas Company. Where abrasion, heat and corrosion are problems, it pays to use Lumnite from the start.

SMOOTH—Gunite made with Lumnite and trap rock sand forms a smooth jointless lining that resists heat in this hot-air duct at the Sewaren generating station.



DURABLE—Gunite made with Lumnite and trap rock sand resists corrosion in this water-filled ash hopper also at the Sewaren generating station. For other jobs, Lumnite with suitable aggregates will resist thermal shock and 2600 °F. heat.

WHETHER YOU NEED a *tough*, *heat-resistant* concrete for flues, ducts, stacks, breechings or ash pits . . . a *corrosion-* and *wear-resistant* bunker lining . . . or a fast, *overnight* foundation—you'll find adaptable Lumnite fills the bill.

Concrete made with Lumnite calcium-aluminate cement is highly resistant to the corrosive attack of sulphurous gases and the abrasive action of high velocity gases and fly ash. Low volume change enables it to withstand high temperatures and severe thermal shock. It reaches service strength in 24 hours or less, so construction or repairs go *fast*.

FOR CONVENIENCE — use castable refractory mixes of Lumnite and selected aggregates to meet specific temperature and insulation requirements. Made by manufacturers of refractories and sold by their dealers. For more information write: Lumnite Division, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y.

FAST—Placed in 15° below zero weather, Lumnite Concrete power-line tunnel gained full service strength in 24 hours. In service over 27 years at International Harvester, Chicago. Use this durable *overnight* concrete and cut costly outage!

*"*LUMNITE" is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

IP-L-70-R

ATLAS® **LUMNITE for INDUSTRIAL CONCRETES**

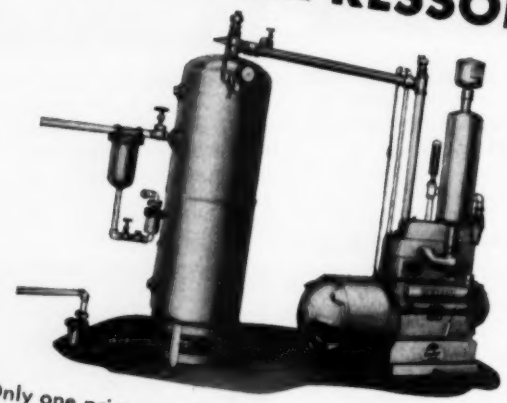
REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

A UNIVERSAL ATLAS PRODUCT

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel Subsidiaries — Sunday Evenings — NBC Network*

NO FOUNDATION COSTS!

THERE'S ONLY 1 PRICE TAG ON A SCHRAMM AIR COMPRESSOR!



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SCHRAMM INC.

The Compressor People

WEST CHESTER • PENNSYLVANIA

readers' guide

(Continued from page 104)

Complete information available on Powermaster packaged boiler with Voriflow combustion. Orr & Sembower, Inc. p 84.

PACKING AND GASKETS

Adv. p 89 contains information on R/M's Big 7 packing types. Raybestos-Manhattan, Inc., Packing Div.

J-M packings are described in adv. p. 40. Johns-Manville Corp.

Key No. 537—Bull No. 4502 describes Darcova pumcups. Darling Valve & Mfg. Co. p 121.

Ajax Spiralwound gaskets are described on p 118. United States Gasket Co.

Key No. 538—Catalog contains complete information on John Crane packings. Crane Packing Co. p 114.

PIPE, TUBING & HOSE

Key No. 539—Cat 500 contains data on seamless & interlocking hose in bronze, steel & stainless steel. Atlantic Metal Hose Co. p 92.

Adv. p 37 contains information on the I-R motorpump line. Ingersoll-Rand.

Key No. 540—Complete range of Ric-wiL piping systems and related products are described in Form 5205. The Ric-wiL Co. p 129.

Key No. 541—Piping Layout No. 65 contains detailed information. Jenkins Bros. p 11.

Key No. 542—Hanger Catalog contains complete data on adjustable pipe hangers and supports. Grinnell Co., Inc. p 41.

PUMPS

Key No. 543—De Laval single stage centrifugal pumps are described in Bulls 1002 and 83-29R. De Laval Steam Turbine Co. p 115.

Key No. 544—Worthington's SESC pump line is described in Bull W300 B-4. Worthington Corp., Centrifugal Pump Div. p 42.

Key No. 545—Johnston close-coupled industrial pumps are described in Bull H-53. Johnston Pump Company. p 24.

REFRACTORY CONCRETES

Literature available on R&I Moldit refractory cements. Refractory & Insulation Corp. p 127.

Adv. p 45 contains data on K&W Kaocast 3000° refractory castables. The Babcock & Wilcox Co., Refractories Div.

(Continued on page 108)

Here's how this strainer "combs" itself clean!

This simple chalk test shows how AUTO-KLEAN's unique built-in comb construction cleans the strainer without costly interruption of flow

ORDINARY BLACKBOARD CHALK leaves heavy deposit of chalk particles on and between discs of Cuno AUTO-KLEAN strainer.

TURNING HANDLE ONE REVOLUTION moves strainer element through comb blades, removing all traces of chalk from between discs. Cuno's exclusive combing operation cleans *thoroughly* —without stopping flow.

FILTERING AREA IS COMPLETELY CLEAN, restoring full initial capacity. All chalk particles and dirt fall to bottom of housing where they can be drained periodically.

- AUTO-KLEAN's permanent metal filter element is available in steel, brass, or stainless steel for long, trouble-free service.
- AUTO-KLEAN is adaptable to any fluid-flow system.
- From acids to tar . . . if you can pump it, Cuno can filter it. Capacities range from one gallon per hour to 15,000 gallons per minute.

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ENGINEERED FILTRATION

Removes More Sizes of Solids From More Kinds of Fluids

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Continuously cleanable AUTO-KLEAN eliminates need for stand-by strainers

You don't have to shut down your fluid-flow system to clean this strainer. Cuno's exclusive "comb-clean" action provides complete cleaning of the element —*without stopping fluid flow.* Thus, you get non-stop filtration, with no need for a stand-by strainer.

Send your industrial fluids—chemicals, water, fuel and lube oils—through an AUTO-KLEAN. The low-pressure drop of AUTO-KLEAN strainers permits *full-flow* operation on gravity, low pressure, high pressure, or suction lines—with no loss in operating efficiency. AUTO-KLEAN's compact construction allows this continuous full-flow filtration in space which would limit ordinary filters to by-pass service.

Fixed-space metal discs in this modern strainer remove all solids larger than the specified disc spacing—from .0035" to .062".

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For permanent, positive fluid protection, install compact Cuno AUTO-KLEAN—the precision-built strainer. Send the coupon for free bulletin. A.3.4

Cuno Engineering Corporation
Dept. 144A, South Vine Street, Meriden, Conn.

Please send me bulletin on Cuno AUTO-KLEAN

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Company.....

Address.....

City.....Zone....State.....

SEE US AT THE PLANT MAINTENANCE SHOW BOOTH 1313

AIRETOOL gives you MORE for LESS

Yes! Proper tube maintenance with Airetool Cleaners gives you MORE efficiency with LESS fuel!

THE AIRETOOL MFG. CO.
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PATENTED
Here's proof . . . the chart tells the dramatic tale of fuel-waste by scale-clogged boiler tubes. BOOST OUTPUT . . . SAVE FUEL by proper maintenance with Airetool Tube Cleaners.
Scale 1/50" thick, 5% additional fuel required
Scale 1/25" thick, 10% additional fuel required
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Scale 1/8" thick, 30% additional fuel required
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Scale 1/2" thick, 150% additional fuel required

The forwardly swing arm type, shown above, is the ideal cleaner head for tubes with short radii. Used with powerful Airetool air or steam driven motors, it will completely clean out the hardest scale. Made for tubes 2" ID to 5⅛" ID.

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There's an Airetool Tube Cleaner and Tube Expander for Every Type of Tubular Construction.

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readers' guide

(Continued from page 106)

Adv. p 105 contains information on Lumnite for industrial concretes., Lumnite Div., Universal Atlas Cement Co.

SOOT BLOWERS & TUBE CLEANERS

Complete details and literature available on Airetool tube cleaners. Airetool Mfg. Co. p 108.

Key No. 546—Bull Y-29 describes Lagonda tube cleaners. Elliott Co., Lagonda Div. p 102.

Adv. p 91 contains information on Diamond soot blowing system. Diamond Power Specialty Corp.

STEAM SPECIALTIES

Key No. 547—Nicholson weight-operated traps are described in Cat 751. W. H. Nicholson & Co. p 90.

Key No. 523—Coupon on p 2 offers Steam Trap Book with data on unit trapping. Armstrong Machine Works.

TOOLS

Key No. 548—Illustrated literature and price list available on RCD drill bit for use with rotary electric or air drill. Rotary Concrete Drill Co. p 125.

Adv. p 125 contains data on Skinner valve and bibb reseater. M. B. Skinner Co.

Key No. 549—Send 10¢ for 68-page catalog of Proto tools. Plomb Tool Co. p 6.

Key No. 550—Industrial and general catalogs describe complete line of Snap-On hand and bench tools. Snap-On Tools Corp. p 120.

TRANSFORMERS

Adv. p 132 contains information on Acme stepdown transformers. Acme Electric Corp.

TURBINES

Key No. 551—Bull 135 contains data on Coppus turbines from 150 hp to smallest size. Coppus Engineering Corp. p 23.

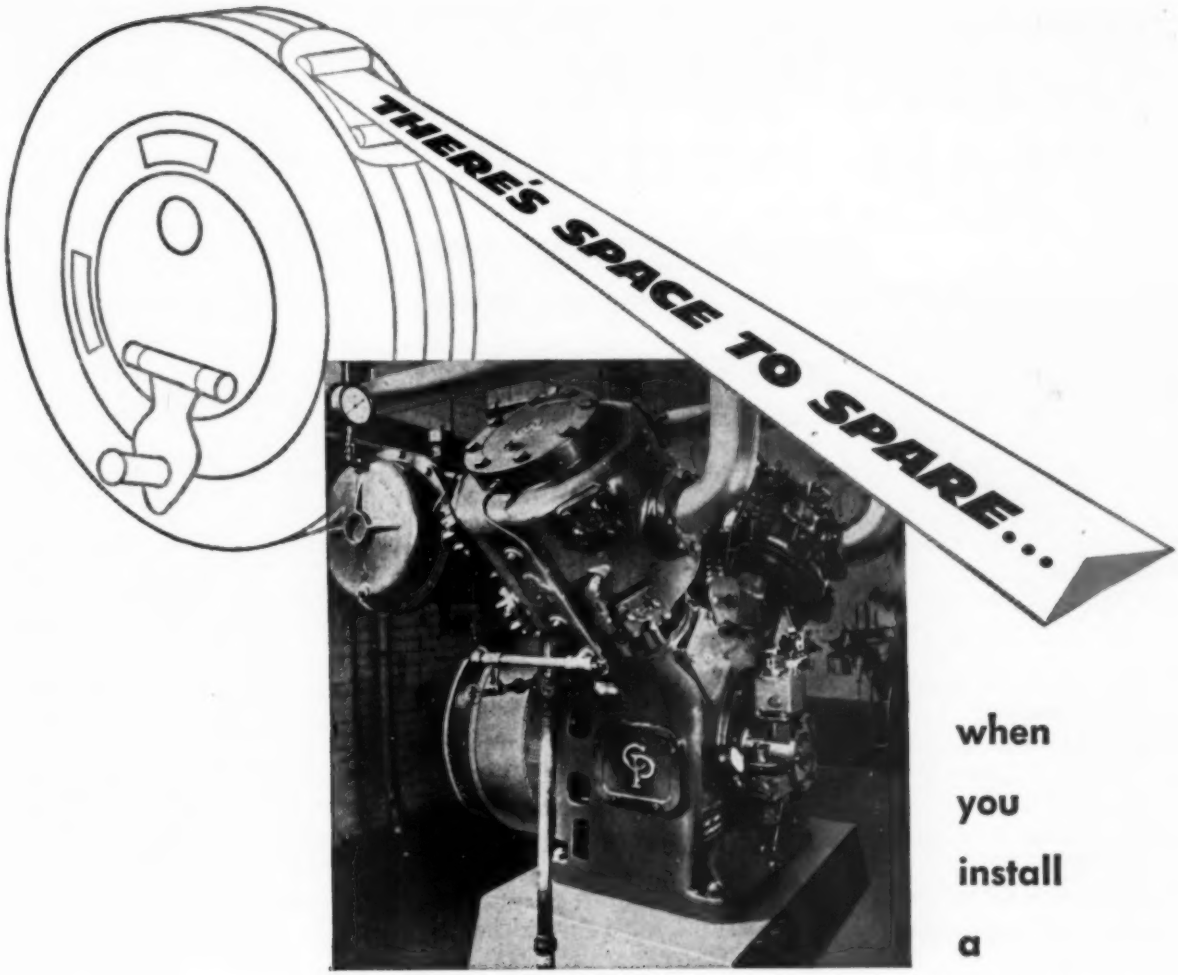
Key No. 552—Data on Terry solid-wheel turbine are contained in Bull S-116. The Terry Steam Turbine Co. p 46.

VALVES

Key No. 553—Leslie double-seated diaphragm control valves are described in Bull 5305. Leslie Co. p 49.

Key No. 554—Catalog gives 4 ways to cut pump repairs. Sims Pump Valve Co., Inc. p 129.

(Continued on page 110)



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TYPE Y

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Where space is limited, industry relies more and more on Chicago Pneumatic's compact, heavy-duty Type Y Compressor. It takes up minimum floor area, yet is ideal for long, continuous heavy duty. Shipped as a complete "package" ready for easy installation, it requires the simplest of foundations—needs no alignment.

The highly efficient Type Y Compressor has roller main bearings, precision connecting rod bearings, multi-step capacity regulation, and an easy-to-clean shell-and-tube intercooler.

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The WING Package—
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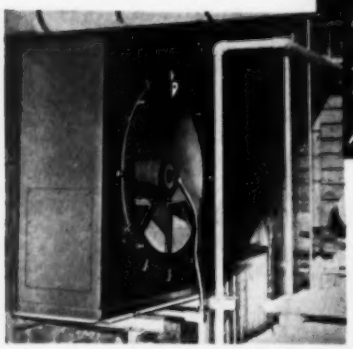

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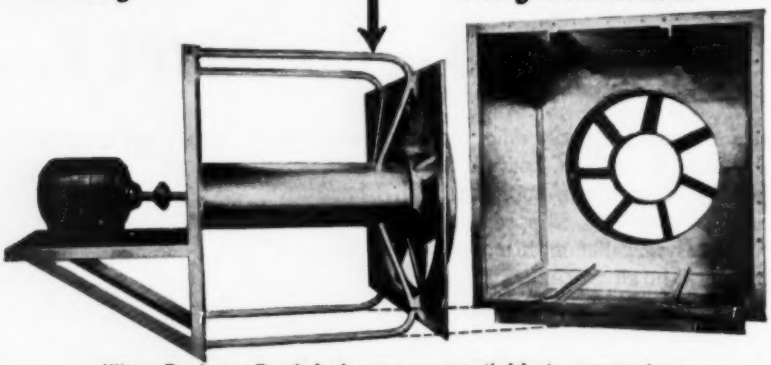
7. All moving parts quickly and easily accessible
8. Saves on investment and maintenance
9. Low load ratings on natural draft because of Wingfoil Fan and ample free gas travel area



Wing Package Draft Inducers are available in many sizes with either turbine or electric motor drive. For further information write

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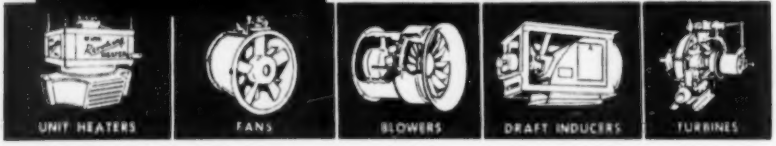

readers' guide

(Continued from page 108)

Key No. 555—Bulletin describes Darling revolving disc gate valves. Darling Valve & Mfg. Co. p 22.

Adv. p 125 describes rubber-lined metal valves with manual or automatic control. W. S. Rockwell Co.

Complete information available on the complete line of Edward forged steel check valves. Edward Valves, Inc. p 93.

Key No. 556—Chapman steel valves in gate, globe, angle and check types are described in Cat 20. The Chapman Valve Mfg. Co. p 17.

Key No. 557—Yarway seatless blow-off valves are described in Bulls B-425 and B-433. Yarnall-Waring Co. p 87.

Adv. p 7 contains information on Crane valves. Crane Co.

HOW TO REQUEST FREE LITERATURE

Insert "key" numbers on return post card found on page 99. For quick reference to free literature offered by advertisers in this issue, refer to listing on page 112. Our Reader's Service Department will handle your request promptly.

WATER TREATMENT

Adv. p 94 contains information on the Graver demineralizer. Graver Water Conditioning Co.

Adv. p 104 describes American automatic Zeolite softeners. American Water Softener Co.

Key No. 558—Free bulletin "Experimental Studies of Boiler Scale at 2,500 psi." National Aluminate Corp. p 15.

Key No. 559—Coupon on p 130 will bring complete details on the Chlorinizer slime control system. Builders-Providence, Inc.

Key No. 560—Bulletin describes Inversand water softening system. Hungerford & Terry, Inc. p 132.

Key No. 561—Brochure SM-9020 describes % Proportioneers% chemical treating systems for boiler water conditioning. % Proportioneers, Inc.% p 21.

Key No. 562—Coupon on p 34 offers Accelator Bull 1825-Y on water treatment. Infilco Inc.

MISCELLANEOUS

See adv. pa 96 for data on powdered rosin for industrial requirements. S. B. Penick & Co.

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FOR LONGER LIFE

In the Spence Regulator, the springs are out of the path of the steam or other fluid flowing through the valve. They operate at low unit stress for exceptionally long life. This is only one of the many Spence design features that assure dependable, accurate regulation year after year. That means less down-time, less time and money wasted on replacement of parts.

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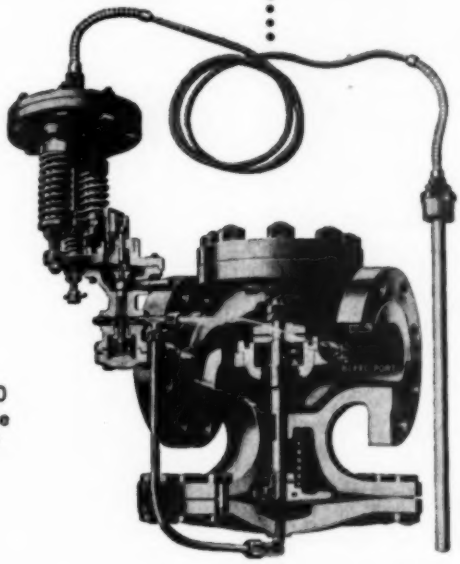

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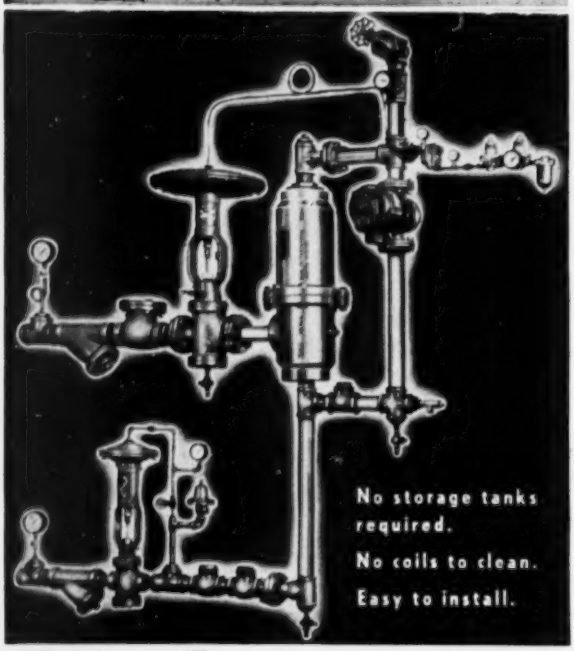

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Anxious to reduce operating costs? What about hot water — it's a big item? PICK Engineers are ready to help you save money on hot water required for any industrial need — processing, showers, washrooms, lab, truck washing, etc. PICK Heaters provide hot water INSTANTLY — by quiet steam injection. No waste of heat! They're entirely automatic to provide and accurately maintain temperatures up to 180° F. No storage tanks required. Easily installed in corners, on walls or overhead. Available in seven sizes with rated capacities of 10 to 300 gallons per minute at 140° F. temperature rise. Greater volumes can be obtained with multiple installations.

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quick reference

to bulletins & catalogs

Page No.	Advertiser	Catalog	Key No.
92	Ames Iron Works Inc.	Amesteam generators	534
2	Armstrong Machine Works	Steam trap book	523
92	Atlantic Metal Hose Co.	Flexible metal hose	539
130	Builders-Providence, Inc.	Chlorinizer slime control system	559
13	Bussmann Mfg. Co.	Dual element fuses	519
117	Chapman Valve Mfg. Co., The	Steel valves	556
132	Chelsea Fan & Blower Co.	Fans & blowers	520
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39	Cleaver-Brooks Co.	Packaged boilers	533
4	Combustion Engineering, Inc.	Type VP package boilers	531
23	Coppus Engineering Corp.	Turbines	551
114	Crane Packing Co.	Packings	538
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121	Darling Valve & Mfg. Co.	Darcova pumcups	537
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115	De Laval Steam Turbine Co.	Single stage centrifugal pumps	543
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126	Engineer Co., The	Baffle-wall constructions	506
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8	I-T-E Circuit Breaker Co.	Metal-Clad switchgear	517
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49	Leslie Co.	Diaphragm control valves	553
131	Liquidometer Corp., The	Tank gage	511
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129	Mercoid Corp.	Mercury switches	514
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31	Powers Regulator Co., The	Temperature control	512
30	Preferred Utilities Mfg. Corp.	Unit steam generators	535
21	%Proportioneers, Inc.%	Chemical treating systems	561
48	Research Corporation	Cottrell precipitator	500
129	Ric-wiL Co., The	Prefabricated insulated piping	540
125	Rotary Concrete Drill Co.	Drill bit	548
43	Rust-Oleum Corp.	Stops rust	502
106	Schramm Inc.	Air compressors	510
129	Sims Pump Valve Co., Inc.	Pump valves	554
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98	Superior Combustion Industries, Inc.	Packaged steam generators	530
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42	Worthington Corp., Centrifugal Pump Div.	SESC pumps	544
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87	Yarnall-Waring Co.	Seatless blow-off valves	557
47	Zink Co., John	CBM gas & oil burner	524

NOTE—List "Key Numbers" on the postal card on page 99

FREE

From Western Precipitation—the organization that pioneered the commercial application of Cottrell Precipitation...

IF YOU ARE ENGAGED in any phase of industry where the recovery of dusts, fumes, fly ash, mists, fogs or other suspensions from gases is a problem, you will find this booklet on the COTTRELL Electrical Precipitator helpful and informative.

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. . . and many other basic Cottrell facts. Write for your free copy of Bulletin C103 today while supplies are adequate!

Western Precipitation is not affiliated with any other company in the field of electrical precipitation except its wholly owned subsidiaries, International Precipitation Corporation and the Precipitation Company of Canada, Ltd. Whether you are now contemplating the installation of a Cottrell Electrical Precipitator, or may be interested in such an installation at a future date, we can and will serve you in any part of the United States or other countries.

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new books

of special interest

Electrical Controls

"Electrical Control Systems," by Richard W. Jones, 3rd edition, John Wiley and Sons, Inc., 511 pages, $7.75.

This book, first published in 1950 and already in its third edition, resulted from a course designed for senior electrical students already well grounded in basic engineering mathematics and electrical theory. The main purpose of the book is to more fully acquaint them with the many types of electrical controls, most of which they would not run across in their laboratory work.

This is the type of text which a student might well carry with him into his professional life. It correlates the many types of electrical controls. The author outlines each type of control and with formulas, sketches, and graphs, explains its operation.

After reviewing the characteristics of the many motor types, the author swings into control devices and, with block diagrams, outlines their application. The control devices range from the well known electro-magnetic contact-making devices to the latest gaseous and electronic devices which almost think for themselves and are capable of controlling operations beyond the power of manual design.

There are chapters on magnetic amplifiers, counter circuits, and motor braking which should suggest many practical applications to the plant engineer. The book is worth its cost in that it probably contains just the control idea that would escape the practical plant engineer.

The author has provided an adequate bibliography for those in search of more detailed information on the subjects covered in the text.

INDUSTRIAL FILMS

"Please Pass the Condensate," color and sound, 20 minutes, Yarnall-Waring Company, Philadelphia 18, Pa. New movie on the subject of up-to-date steam trapping for more production. It portrays the operation, selection, application and maintenance of steam heated equipment through reduced heat-up time and hotter operating temperature, as well as shortened down-time for repairs and cleaning. Available for showing to engineering and plant groups.

"The Sky Is the Roof," color and sound, 12 minutes, Allis-Chalmers Manufacturing Company, General Machinery Division, Milwaukee 1, Wis. A brief background history of the development of the weather-protected motor is presented in this film. It shows storm tests to which these motors are subjected. The movie shows how such a motor, while running at normal speed and voltage, can be deluged with water and buffeted by winds, yet no moisture can be detected on the windings.

Take a good look at this critical PACKING INSTALLATION...

Style 805-MBF Used On This 10-Stage High Pressure Boiler Feed Pump

This set of packings is going to handle a tough job. The pump is rated at 965 gpm, 4250′ total head, handling *hot* (312°F.) boiler feed water at 89# suction pressure and driven by a 3850 rpm induction motor (shaft sleeves are chrome plated—675 Brinell).

There are many styles of "John Crane" Packings—but Style 805-MBF was recommended and used because it was developed *and developed alone* for high speed centrifugal boiler feed pumps. The natural lubricating characteristics in the design of the monel and asbestos yarn braid-over-braid construction makes it a strong, wear resistant packing. Used in hundreds of installations all over the world—it has proved to be a highly efficient, long-life, trouble-free packing that gives you the results you want.

For quick action, let our Engineering Department help you. Write for latest "John Crane" Packings Catalog. Crane Packing Company, 1831 Cuyler Avenue, Chicago 13, Illinois.

JOHN CRANE CRANE PACKING COMPANY

meetings

and exhibitions

MAY

May 10-15, **American Water Works Association, Inc.,** annual national convention, Grand Rapids, Mich.

May 11-13, **Heat Exchange Institute,** The Greenbriar, White Sulphur Springs, W. Va.

May 18-22, **Fifth National Materials Handling Exposition,** Convention Hall, Philadelphia.

May 24-28, **American Society of Mechanical Engineers.** Oil and Gas Power Div. conference, Hotel Schroeder, Milwaukee.

May 25-27, **Hydraulic Institute,** Seaview Country Club, Absecon, N. J.

JUNE

June 16-19, **American Welding Society,** exposition, Shamrock Hotel, Houston, Texas.

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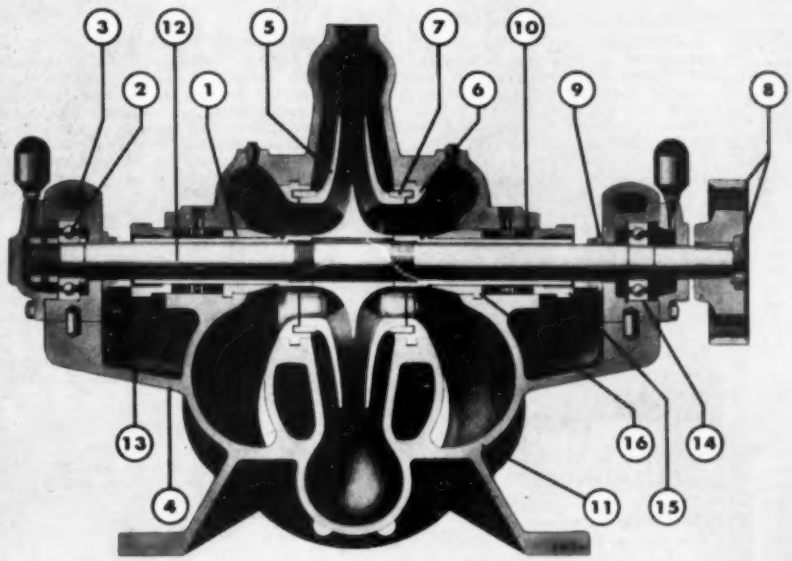
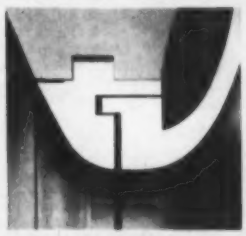
CENTRIFUGAL PUMPS

for dependable industrial service



Labyrinth wearing rings minimize leakage...maintain high efficiencies



Labyrinth rings used in these De Laval pumps retard flow of water through labyrinth passage.

Flat rings showing relatively unimpeded flow of water.

① **Shaft Sleeves** are screwed on, to abut the impeller and make a water-tight joint. Sleeve expands freely and independently of shaft when temperatures change. There is no tendency to buckle.

② **Thrust Bearing** locates rotor axially.

③ **Bearing Caps** easily removable for maintenance.

④ **Bearing Brackets** scraped to lining bars for perfect alignment.

⑤ **Impeller** hydraulically balanced, finished on all surfaces.

⑥ **Labyrinth Wearing Rings** held accurately in machined grooves in both case and cover.

⑦ **Impeller Wearing Rings** threaded on impeller, opposite to rotation.

⑧ **Flexible Coupling** ground on all exposed surfaces and statically balanced, complete coupling supplied, pump half mounted on taper so that it can be easily removed. Check nut locks coupling on taper.

⑨ **Deflector** keeps water out of bearing.

⑩ **Stuffing Boxes** extra deep; lantern rings for water sealing.

⑪ **Pump Case** horizontally split; machined to limit gages.

⑫ **Steel Shaft** ground to limit gages.

⑬ **Drip Boxes** large; provided with drain openings.

⑭ **Radial Bearing** free to move axially, thus avoiding temperature strains.

⑮ **Glands** split horizontally.

⑯ **Protecting Bushings** renewable.

You can count on the performance of the De Laval Single Stage Centrifugal Pumps because they are precision-made to high manufacturing standards and incorporate the many quality design features shown in the cross-section.

They operate at high or low speeds, at high or low heads...with maximum efficiency.

For example, De Laval G, I and K Single Stage Double Suction Pumps have a capacity range of 175 gpm to 6,000 gpm, and heads to 300 feet. They are available in sizes ranging from 4" suction and 3" discharge to 14" suction and 12" discharge. Write for Bulletin 1002.

DeLaval also furnishes larger centrifugals for capacities up to 70,000 gpm. Bulletin 83-29R sent on request.

DE LAVAL *Centrifugal Pumps*

DE LAVAL STEAM TURBINE COMPANY

857 Nottingham Way, Trenton 2, New Jersey

DL 198

new bulletins

and catalogs from leading manufacturers

COAL, ASH & BULK HANDLING

200—Pneumatic Conveying Systems

Adaptability of pneumatic conveying for bulk handling and transporting of pulverized, granular, and small broken materials is the subject of an 8-page bulletin. In addition to describing the elements of pneumatic systems, the bulletin discusses many typical installations. The advantages of pneumatic conveying are described. Holly Pneumatic Systems, Inc.

201—Coal Scale

Described in 16-page bulletin 0352 is an automatic coal scale for weighing coal as it is fed to boilers. Construction and operating details are presented for the belt feeder, the weigh hopper, scale housing, operating levers, and accessories. The booklet also contains an explanation of how the unit operates and information on special features. Richardson Scale Co.

AIR & DUST FILTERS & COLLECTORS

202—Tubular Dust Collectors

Problems of fly ash collection are discussed in 8-page brochure 4P201. Tubular dust collectors are described, and efficiency curves, arrangements, and standard dimensions are presented. Flue gas density tables, and a formula and nomograph for calculating the number of tubes required for any volume and resistance, are presented to aid in selecting dimensions for a unit to satisfy space requirements. The Thermix Corp., Project Engineers.

203—Cloth Screen Collector

Advantages of a self-cleaning cloth screen dust collector are tabulated in 16-page folder 915. How the unit maintains constant collector performance and efficiency is discussed. Design details, construction, and specifications are included. Pangborn Corp.

CONTROLS, REGULATORS & INSTRUMENTS

204—Pyrometers

Pyrometers for the indication and control of temperature and industrial processes, and for the protection of heat-processing equipment, are described in 12-page booklet GEC-713B. Design features, applications, operation, functional principles, construction, and specifications for various types of indicating and controlling pyrometers are presented. Information on thermocouple components, hand pyrometers, thermocouple potentiometers, resistance thermometers, and industrial resistance bulbs also is presented. General Electric Co.

205—Controllers

Free-vane air-operated controllers are described in 32-page booklet A120. Instruments for automatic control of pressure, temperature, liquid level, flow, humidity, pH, and electrical variables are described. Data are provided on on-off, proportional, reset, derivative, reset plus derivative, and autoset types of controllers. The Bristol Co.

206—Annunciator Systems

How annunciator systems work, and what they consist of, is described in 38-page booklet 100. Component parts of the system are discussed. Considerable information is included to aid in designing. The subject of layouts for hazardous locations also is dealt with. Panalarm Products, Inc.

207—Recording Meter

Described in 20-page bulletin 401 is a mercury flow type indicating, recording, and totalizing meter for accurate measurement of water, gas, air, sewage, sludge and industrial liquors. Descriptions of the meter include facts on its operation, construction, general information, sizes and capacities, specifications, and other pertinent data of interest to plant engineers. Simplex Valve & Meter Co.

208—Controllers

Control instruments used to measure and control numerous process variables are the subject of 60-page booklet 1530. Specifications and ratings for both electric and pneumatic type controllers are presented, together with descriptions of the control action. In addition, engineering data on electrical control relays are presented. Industrial Div., Minneapolis-Honeywell Regulator Co.

209—Regulators

"How to Select Regulators," a 40-page booklet, provides useful data for simplifying the selection of pressure regulators, temperature regulators, or pump governors to do a specific job. Steam, gas, and water capacity tables are presented, together with suggestions for installation and other useful information. Foster Engineering Co.

210—Regulating Valves

Valves for controlling the flow of gases and liquids by means of floats, master regulators, or thermostats, are the subject of 12-page bulletin S-22-CA. Specifications, advantages, and construction of diaphragm-operated, spring opening and spring closing regulating valves, pressure controllers, air locks, valve positioners, and selector panels are presented. The Swartwout Co.

211—Chemical Feeder Control

Improved processing through automatic control of chemical feeders is described in 4-page data sheet, AED 000-10. Designed for application to the Lapp Pulsafeeder pump, the instrumentation permits automatic feeding of treating chemicals either to maintain uniform concentrations or to correct variations of pH in any continuous process. Separate sections of the folder describe feeder control in relation to flow rate, changing the feed rate by ratio-set mechanism, range of ratio adjustment, and control of pH under varying flow conditions. The Foxboro Co.

212—Mass Spectrometer

Announcement of a new mass spectrometer designed primarily to monitor and control continuous processes in chemical plants and oil refineries, is made in 4-page folder CEC-1824. In addition to specifications, subjects such as how it operates and how it is used for process monitoring and control are discussed. Consolidated Engineering Corp.

BATTERIES & CHARGERS

213—Nickel Cadmium Batteries

Engine starting characteristics of nickel cadmium batteries are described in a 4-

(Continued on page 118)

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For high-pressure, high-temperature service (as well as sub-zero duty), Chapman makes steel valves in a range of series from 150 to 2500 lb . . . in gate, globe, angle and check types . . . in steels of many different analyses and with suitable trim to resist corrosion and erosion.

Chapman Steel Valves are accurately machined and finished, designed to ASA and API ratings, and may be furnished with flanged or welding ends. These valves can be equipped for any type of operation . . . hand, gearing, hydraulic cylinder or Chapman motor unit as shown in illustration. So for all standard and any special Steel Valves, check with Chapman *first*. Meanwhile, write for Catalog 20.

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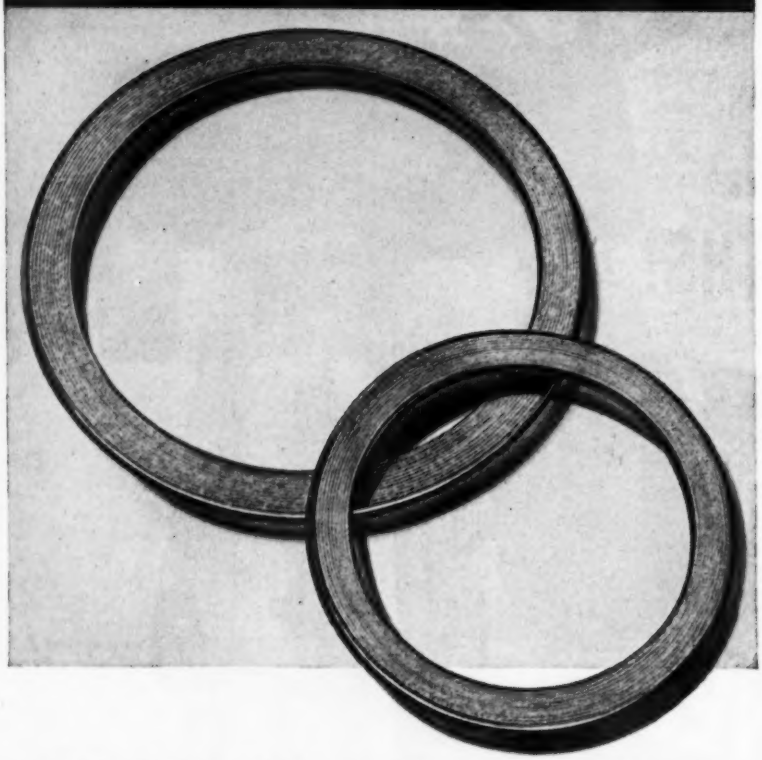

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new bulletins

(Continued from page 116)

page folder. It discusses the principles behind the low-internal-resistance and negligible self-discharge qualities of the batteries, and outlines reasons for their long-life and trouble-free reliability. Nickel Cadmium Battery Corp.

BUILDING MATERIALS & MAINTENANCE

214—Sump Cleaning

Sump cleaning with vacuum equipment is the subject of 4-page folder 130-C. According to the bulletin, this equipment can pick up liquids at the rate of 40 gpm, with a tank capacity of 125 gal. Improved vacuum equipment for picking up water from floors and ducts also is described. The equipment may be connected to a vacuum cleaning system, or may be provided as a portable unit with capacities to 8 gal. The Spencer Turbine Co.

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BOILERS & BOILER ACCESSORIES

215—Steam Accumulators

Balancing steam supply and demand with steam accumulators is the subject of 8-page bulletin RA-52-8. Typical installations are discussed. Principles of operation and advantages are described, and data are presented for calculating capacity. The practical application of accumulator theory is discussed. Foster Wheeler Corp.

216—Gage Valves

Liquid level gage valves for liquid and flat glass gages are described in a series of nine data sheets 187-195. Specifications are listed, and such details as operation and advantages are presented. Jerguson Gage & Valve Co.

FANS & BLOWERS

217—Centrifugal Fans

Centrifugal fans, designed for high velocity air conditioning systems and heavy duty industrial applications where low operating cost and quiet operation are required, are the subject of 8-page booklet 1320. A graph shows horsepower, efficiency, and pressure ratings. Brief descriptions of five classes of fans give maximum wheel speeds, total pressures, and volume ranges for each class. Design features are discussed, and a special section describes a system of movable vanes for controlling fan output. Sturtevant Div., Westinghouse Electric Corp.

MECHANICAL POWER TRANSMISSION

218—Roller Chain & Sprockets

"How to Select Standard Roller Chain Drives," a section of 54-page booklet 52-1, provides useful formulas, tables, and ex-

amples to aid engineers concerned with drive equipment. Advantages are discussed, and dimensions, strengths, and weights are tabulated. Stock sprockets also are described, including bore, keyway, and setscrew information. Proper maintenance of chain drives is reviewed, and information on chain vises, flexible couplings, and coupling covers is provided. Baldwin-Duckworth Div., Chain Belt Co.

219—V-Belts

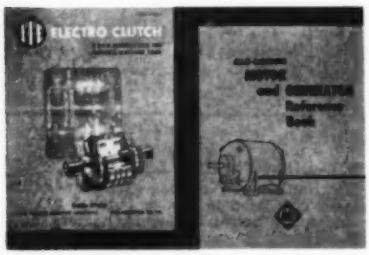
Fractional horsepower V-belts, for use in servicing light duty applications, are listed according to the new industry-standard numbering system in a new catalog. Various types of machines are listed alphabetically by company or tradenames for convenience in determining the proper belt. Manhattan Rubber Div., Raybestos-Manhattan, Inc.

220—Gear Drives

How to select herringbone gear drives is explained in the engineering data section of 40-page booklet 2519. Tables list ratings, overhung loads, and specifications. Construction, applications, and advantages of single, double, and triple reduction enclosed herringbone gear drives are presented. Units are listed in standard ratios from 2.84:1 to 326:1. Capacities range from 0.4 to 2480 hp, and output shaft speeds range from 2.2 to 623 rpm. Link-Belt Co.

221—Electric Clutch

Principles of operation of an electrically controlled clutch are explained in 16-page bulletin 5306. The unit is used to connect or disconnect a driven shaft from a driving shaft while the latter is either running or standing still. It was developed and is widely used in Europe for machine tools. The bulletin gives engineering information on how to apply, how it operates, and control. Specifications are listed. Rectifier Div., I-T-E Circuit Breaker Co.



MOTORS & GENERATORS

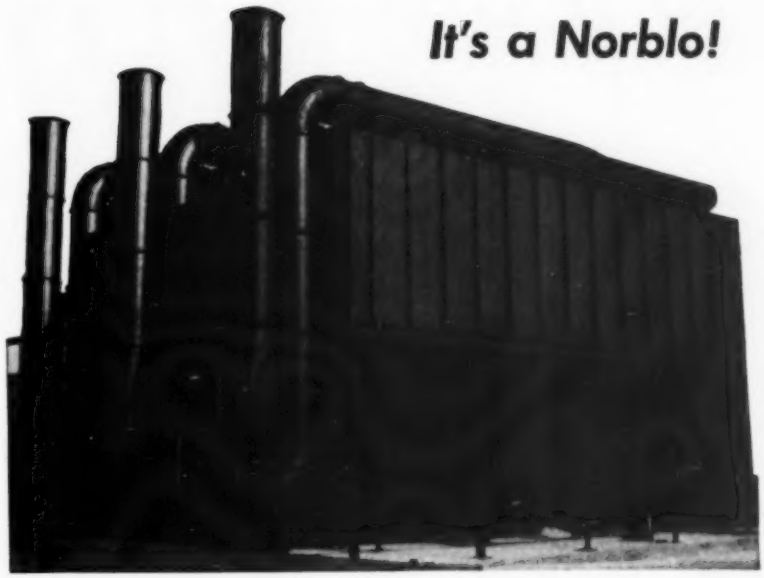
222—Reference Book

"Motor and Generator Reference Book," 50-page booklet 51R7933, presents information to assist in the selection of motive power to handle most industrial applications. Considerable data and information of value are presented and supplemented with illustrations. The booklet is reprinted from the 1952 edition of "Lincoln's Industrial-Commercial Electrical Reference." Allis-Chalmers Manufacturing Co.

223—Motor Starters

How to select the correct starter for squirrel-cage induction motors rated up to 600 v, is the subject of 4-page selection guide 14B7733. Information tells how to select the proper type starter, enclosure and operating arrangement, and explains how to determine whether a full or reduced voltage starter should be used. An explanation of two or three-wire control and hints on selection of heater elements for overload relays also are given. Allis-Chalmers Manufacturing Co.

(Continued on page 120)



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Of all the major types of dust and fume collection systems, the modern automatic bag type process as developed by Norblo is the most widely useful and adaptable. Its use in important large scale production processes extends from coast to coast, and to foreign lands.

Continuous operation at full rated capacity — handling heavy dust loads by maintaining a constant suction drop across the arrester — is the performance that Norblo Equipment delivers day after day.

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Norblo also builds centrifugal and hydraulic dust collectors, exhaust fans, cement air cooling systems, and portable type dust collectors. Write for literature on any of these.

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*Snap-on is the trademark of Snap-on Tools Corporation.

new bulletins

(Continued from page 119)

224—Dripproof Induction Motors

Dripproof induction motors, from 1/3 to 150 hp, are described in 6-page brochure RS-2. In addition to standard motors, special purpose types such as vertical, flange and face mounting, magnetic brake-types, and shell-type units are discussed. Speed torque curves, frame number charts, dimensions, and specifications are presented. Recent changes in design are discussed, including use of prelubricated, sealed ball bearings throughout. The Lima Electric Motor Co.

HEAT EXCHANGER EQUIPMENT

225—Air-Cooled Heat Exchangers

Forced draft, air-cooled heat exchangers, for a wide variety of industrial cooling and condensing applications, are discussed in 12-page bulletin FF-FD-0.001. How they operate, construction, and design features are discussed. Data on heat transfer, horsepower, and space requirements are included in a discussion of applications. The Fluor Corp., Ltd.

226—Condenser Tube Inserts

How to restore leaking condenser tubes to service by sealing off the deteriorated portion with inserts, is the subject of 4-page folder 500. The booklet also describes installation and advantages. Tube cleaners, expanders, and maintenance tools also are listed. Thomas C. Wilson, Inc.

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227—Heat Transfer Equipment

Various types of heat transfer equipment are listed in 8-page bulletin 945. Included are heat exchangers, heaters, coolers, coils and bends of pipe and tubing, pressure vessels, and prefabricated plate products. Brief descriptions of each product are presented. The Whitlock Manufacturing Co.

PACKAGE STEAM GENERATORS

228—Scotch Marine Boiler

Subject of 16-page bulletin 509 is an automatic, self-contained steam generating plant for firing oil, gas, or combination oil and gas. Construction of the boiler and firing equipment is described. Specifications are listed for units up to 250 psi for power, process, or heating; and units for 15 psi steam or 30 psi water for low pressure heating. Standard and extra equipment is discussed. Suggestions for installation and maintenance also are presented. Johnston Brothers, Inc.

229—Package Automatic Boilers

Featured in 12-page bulletin 1218 is a cut-away view showing design of a package automatic boiler. Component parts, performance, advantages, and types of equipment also are discussed. Units are equipped with air atomizing oil and free-mix gas burners, which can be quickly converted from oil to gas or from gas to

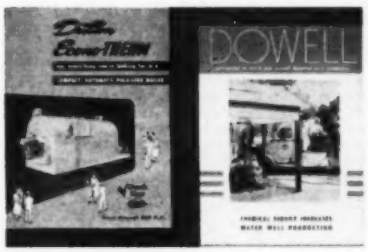
oil without additional piping of wiring. Ratings from 15 to 500 bhp are listed. Orr & Sembower, Inc.

230 Automatic Boilers

Data and specifications for package automatic boilers from 20 to 500 bhp are listed in 4-page folder 102. Design features and advantages are discussed. Combination oil and gas burners are described. Boiler Engineering & Supply Co., Inc.

231—Off-Center Firing

Design features of a compact, automatic package boiler are discussed in 4-page folder EC-1152. The theory of off-center firing, used with these units, is discussed. Specifications for units through 250 hp are tabulated. Dutton Boilers Div., Hapman-Dutton Co.



WATER TREATMENT

232—Water Well Acidizing

How to acidize water wells, and what it can do to increase water yield, is discussed in a 12-page reprint. In addition to presenting engineering data, the booklet discusses results of water well acidizing in various parts of the country. Dowell Inc.

DIESELS

233—Gas-Diesel Engines

Engines for gas, gas-diesel, and diesel operation are described in 12-page bulletin L-71. Units are 4-cycle, with 15½ in. bore and 22 in. stroke. A rating curve compares supercharged to atmospheric operation. Aftercooling for more horsepower is discussed. Space requirements are listed, and typical installations are described. Cooper-Bessemer Corp.

234—Diesel Electric Sets

Five models of diesel electric sets, with ratings up to 110 kw, are described in 20-page bulletin 30507. A cutaway view shows features of design. The booklet describes fuel, lubrication, and cooling systems; points out advantages of several important parts; contains descriptions of both self-regulated generators and completely automatic standby sets; describes attachments; and gives complete specifications. Caterpillar Tractor Co.

235—Dual Fuel Engines

One of the interesting features of 16-page bulletin 202 is a schematic diagram of a dual fuel engine, showing starting air, fuel oil, pilot oil, and gas lines. Operation, advantages, and construction also are described. Descriptive data on the pilot oil injection system, hydraulically actuated gas valves, forced feed lubrication, and positive action safety devices are presented. Nordberg Manufacturing Co.

236—Heavy Duty Engines

"New Developments in Oil Diesel, Dual Fuel Diesel and High Compression Spark Ignition Engines," 16-page booklet S-500-B55, describes up-to-date features of modern, economical, heavy duty, internal com-

(Continued on page 122)

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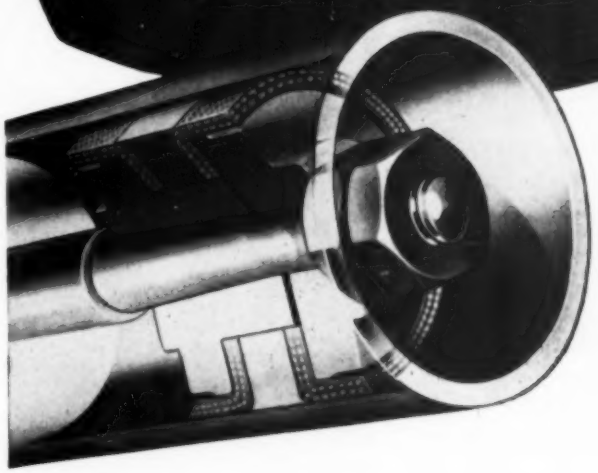
higher efficiency
WITH DARCOVA PUMCUPS
ON THE JOB!



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Secondly, efficiency *does not diminish* as Pumcups wear. Response is always faster, surer, with less power consumed!

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THE ORIGINAL COMPOSITION CUP
PUMCUPS

You Get Trustworthy Liquid or Gas Cooling With Great Cooling Water Savings from the NIAGARA AERO HEAT EXCHANGER

● You can cool air, gas, water, oils, chemicals, electric and power and process equipment, engines, mechanical processes with lower cost and really accurate control of temperature with the Niagara Aero Heat Exchanger.

You are assured of uniform, constant production and quality from any process . . . steady, reliable operation . . . lower cost for more dependable cooling. You can have closed system cooling with freedom from scale, dirt, corrosion and maintenance troubles. You can accurately cool more than one type of liquid with one machine.

The Niagara Aero Heat Exchanger uses atmospheric air to cool liquids and gases by evaporative cooling. You can remove heat at the rate of input to keep accurate control of gas or liquid temperature. You can put heat back into the system to save the losses of a "warm-up" period or to equalize the effect of load variations.

Great savings in cooling water and savings in piping, pumping and power return the cost to you quickly. The Niagara Aero Heat Exchanger can save you approximately 95% of your cooling water cost. Write for Bulletin 120.

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Experienced District Engineers in all Principal Cities of U. S. and Canada

new bulletins

(Continued from page 121)

bustion engines. A heat balance chart shows waste heat recoverable from exhaust gases and jacket cooling water. Also included is bulletin S-500-B54, which contains fuel cost charts for determining most economical type of engine selection, and reprints describing industrial and municipal installations utilizing heat recovery systems. Engine Div., Worthington Corp.

DIESEL & ENGINE ACCESSORIES

237—Cylinder Liners

"Water Side Deterioration of Diesel Engine Cylinder Liners," 8-page reprint, deals with problems in water cooling of diesel engines. Reasons are given for failure of protective measures to stand up in service, and certain steps are outlined that may be expected to provide effective remedies. Illustrations supplement the text. The International Nickel Co.

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FUELS AND FIRING EQUIPMENT

238—Over-Fire Air Systems

"Smoke is Wasted Fuel," a 4-page folder, describes how over-fire air systems operate. How an automatic control with electric eye can be applied to the systems is explained. Instructions on how to select the proper size are presented, together with a selection chart and a table of fan data and characteristics. Canton Stoker Corp.

239—Oil Burning Equipment

Oil burners, combination gas and oil burners, oil pumps, and accessories are described in 20-page booklet 3048. Subjects such as how to select a burner, engineering and manufacturing factors, construction features, principles of operation, typical installations, basic firing operation, automatic operation, and use of panel or control boards are presented. Engineers concerned with selection of firing equipment should find considerable information of value in this booklet. Petro Div.

ELECTRICAL DISTRIBUTION

240—Feeder Voltage Regulator

How to install, operate, and maintain feeder voltage regulators is the subject of 28-page "Users Manual" O1X7002B. The manual includes connection and installation diagrams, tables for calculating setting of line drop compensator, gives maintenance hints, and describes such specialties as the Vari-Amp feature, forced air cooling, and oil-sealed inert gas protection. Allis-Chalmers Manufacturing Co.

241—Non-Metallic Power Cables

Construction features and advantages of zero to 5000 v non-metallic, sheathed power cables, for direct burial installations,

(Continued on page 124)

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- Precision-built indicators provide accurate temperature readings.
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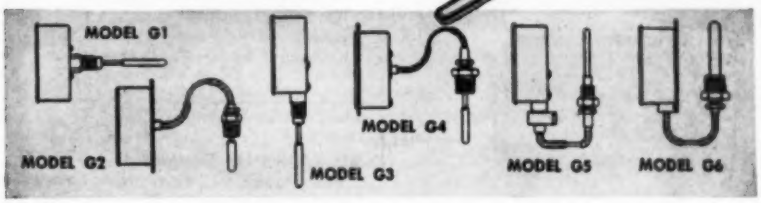

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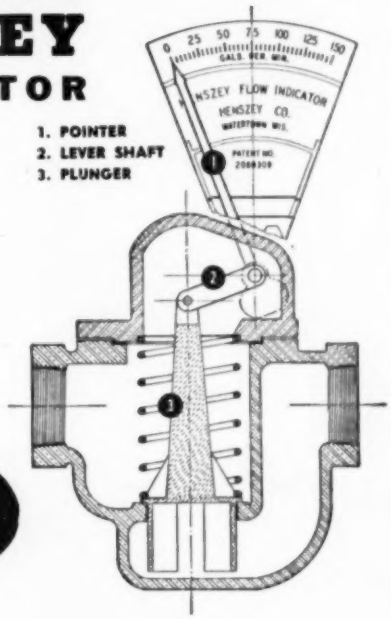
1. POINTER
2. LEVER SHAFT
3. PLUNGER



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new bulletins

(Continued from page 122)

are discussed in 12-page bulletin OK-1066. Current carrying capacities and specifications are tabulated. A section entitled, "How to Install Buried Cable," contains useful information for extending cable life and preventing service interruptions caused by mechanical damage. The Okonite Co.

242—Power Conversion Units

Metallic rectifier power conversion units are the subject of 8-page bulletin GEA-5658B. The publication lists design features, advantages, descriptions, performance, circuits, and rating for units from 125 to 250 v d-c. A guide also is provided as an aid in preparing contract specifications which entail d-c power supplies and exciters. Drawings show outline dimensions. General Electric Co.

ELECTRICAL HEATING UNITS

243—Electric Heaters

Electric unit heaters and heater sections for industrial and commercial heating, as well as for specialized use in heating corners of factories, warehouses, and guardhouses, are described in bulletin E-1. The principal features of three basic types are discussed. Electric duct heater sections for oven-work, drying operations, and similar process heating also are described. Engineering data includes capacity tables and dimensions. L. J. Wing Mfg. Co.

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ELECTRICAL INSULATION

244—Asbestos Insulation

Information about electrical insulations made of purified asbestos—why they were developed, what their characteristics are, and where they may be used to advantage—is contained in 32-page booklet EL-40A. Tables give test data on physical and electrical properties. Illustrations show application techniques and advantages. Literature suggests applications for core tubes, layer insulation, layer wrapping, interlaminant insulation, end washers, and final wrapper insulation. Johns-Manville.

LUBRICANTS, LUBRICATION, FILTERS & PURIFIERS

245—Oil Reclaimer

Subject of 4-page folder R-247 is a self-contained, compact oil reclaimer for keeping industrial oils free from contaminants. In addition to describing how the process works, the bulletin suggests a few of the more common applications. The Hilliard Corp.

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246—Filtration Equipment

How various industrial plants have used filtration equipment to solve specific problems is discussed in a series of 4-page case studies. Each study discusses the problem and its solution. The first folder appraises a central system for reconditioning cutting oil before it reaches automatic machines. A second study describes a central flotation system for clarification of soluble coolant. Industrial Filtration Div., U. S. Hoffman Machinery Corp.

PIPE, TUBING, & HOSE

247—Flexible Metal Hose

Various types of flexible hose applications are pictured in 6-page folder CMH 122R. Basic types, as well as standard assemblies and special purpose types, are discussed. A chart shows the proper type of assembly to use for handling various types of liquids, gases, solids, and semi-solids. Flexonics Corp.

MATERIALS OF CONSTRUCTION

248—Vibration Mounting Systems

All-metal engineered mounting systems for maximum vibration isolation and shock protection of electronic equipment is the subject of 16-page bulletin 750. The booklet defines vibration and shock, shows the effect of vibration on equipment, what can be done about vibration, and the application of knitted stainless steel wire as the resilient and damping element. Vibration control from theory to practice is explained. Robinson Aviation, Inc.

249—Structural Plastic

Information on fabrication and design factors, physical strength, and chemical resistance of unplasticized, rigid polyvinyl chloride is provided in 6-page folder 9-1. Techniques of fabrication are dis-

(Continued on page 126)

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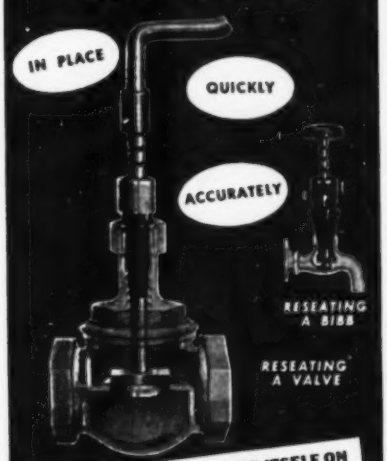

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new bulletins

(Continued from page 124)

cussed, with illustrations of fume exhaust systems, tanks, ducts, dipping baskets, and similar products. Resistance characteristics are charted to clearly indicate applicability to specific industrial corrosion problems, as well as its resistance to reagents at both low and high temperatures. Atlas Mineral Products Co.

PUMPS

250—Controlled Volume Pumps

Described in 4-page folder H20M is a recently developed positive displacement pump designed for water treating and other industrial applications which do not require extreme accuracy. Applications, capacities, materials of construction, and motor-drivers are discussed in the bulletin. Milton Roy Co.

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251—Multi-Stage Pumps

Pumps for supplying, circulating, and boosting water and process liquids are described in 12-page brochure B-1400. Specifications are tabulated, and construction is described for 2, 3, 4 and 5 stage split-case units. Capacities up to 3000 gpm, and heads to 1550 ft are listed. Peerless Pump Div., Food Machinery and Chemical Corp.

252—Rotary Gear Pumps

"How to Solve Pumping Problems," is the title of 36-page booklet 3060. In addition to presenting typical problems and their solutions, various types of rotary gear pumps are described. The major portion of the book is intended to serve as a data handbook. Nomographs of friction loss in pipe, resistance of valves and fittings, and viscosity of oils are included. In addition, viscosities and specific gravities, conversion tables, electrical data, and construction materials are presented. Geo. D. Roper Corp.

STEAM SPECIALTIES

253—Separators & Purifiers

Live steam separators, exhaust steam separators, air and gas separators, receiver type separators and steam purifiers, and exhaust heads are described in 24-page catalog 500. Design features, proper trap to use, and specifications are presented for each type. Engineering data includes charts giving pressure drop, steam capacity, and air capacity, as well as nomographs of steam flow in pipes and pressure drop in steam piping. Wright-Austin Co.

THERMAL INSULATION

254—Spray-Applied Insulation

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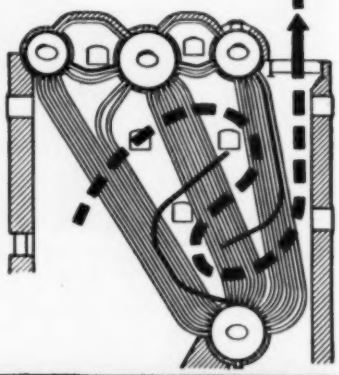

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of charts. The coating is described as providing moderate insulation as well as protection from corrosion. Recommended applications include protection of heated storage tanks, and control of condensation on cold pipes and vessels. Charts give dew point for uninsulated pipe and for surfaces with 1/4 and 3/8 in. sprayed insulation. Surface temperature of the insulation also is tabulated. Insul-Mastic Corporation of America.

VALVES

255—Engine Stop Valve

Automatic shut-down of turbine, compressor, or engine in event of over-speeding, is provided by a combined throttle and engine stop valve described in 6-page folder S-3. Applications, fabrication, installation, and design, along with a complete parts list, dimensions, and specifications, are presented. Golden-Anderson Valve Specialty Co.

MISCELLANEOUS

256—Desk Calculator

Useful formulas, constants, and conversion factors for basic engineering of blast cleaning and dust control calculations are contained in a 6-page pocket size folder entitled "Desk Calculator." Included are geometric relationships for circles, squares, cylinders, spheres, pyramids, cones, and trapezoids; measures of pressure; and calculation guides for determining tank capacities in gallons. Other major categories include formulas for dust control work, tables on shot and grit sizes, and metric measurements and conversion factors. Pangborn Corp.

—*End*

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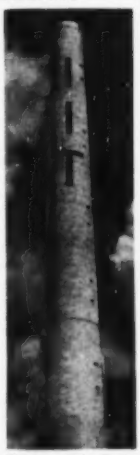

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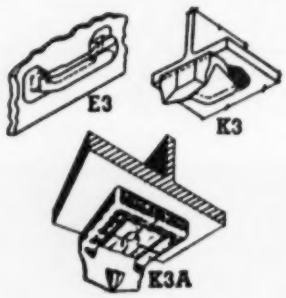

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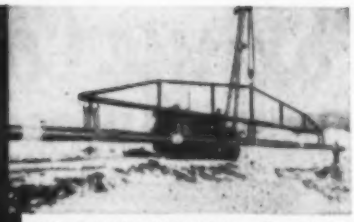

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Fel-Pro's exclusive Colloidal-Copper formula allows for easy separation and reduces stud breakage of threaded assemblies after long exposure to extreme temperatures. It eliminates galvanic pitting of stainless and alloy steel even where dissimilar metals are joined.

Conduct your own tests with C-5 "Hi-Temp" at our expense. See how it can lick your toughest thread breakage problems . . . Write for FREE Sample and complete data sheet TODAY!

NO MORE FROZEN OR GALLED STUDS EVEN AT 1800° F

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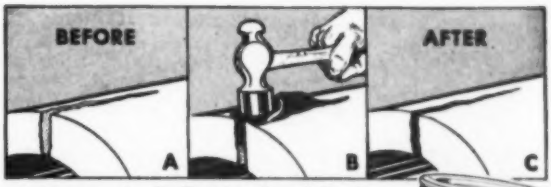

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Smooth-On No. 1 Iron Cement is a metallic powder which you mix with water to the consistency of putty. You tamp it, while still soft, into a crack or hole, making sure to force it against all surfaces. With Smooth-On you don't need to use heat or special gadgets. As it hardens, it expands slightly, clinging tightly in place. The required part is ready for use as soon as Smooth-On sets hard. Keep Smooth-On handy for both emergency and routine maintenance repairs. Buy it in 7 oz., 1 lb., 5 lb., 20 lb., or 100 lb. sizes. If your supply house hasn't Smooth-On No. 1, write us.

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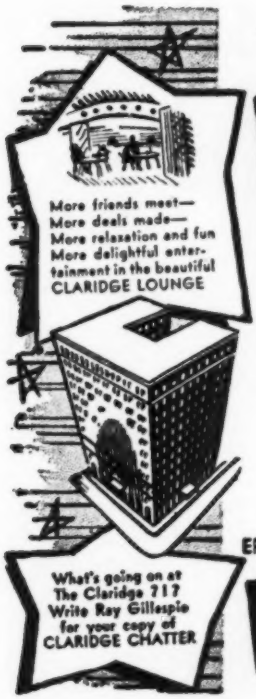

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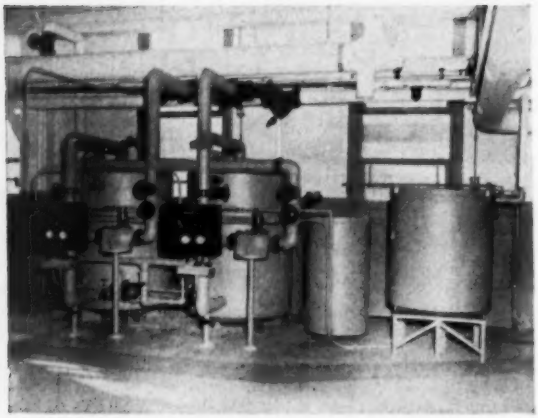

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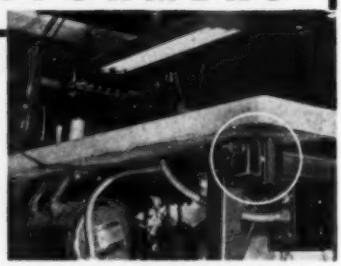
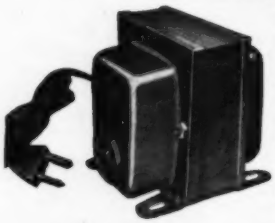


• Acme Stepdown Transformers are available in standard ratings from 75 to 2000 watts. Ready for easy installations.



Motorized machines that are individually lighted (with a concentrated light at the working area) can be shifted in production lines with a minimum of expense and delay. An Acme Electric stepdown transformer mounted on the machine and connected to the power line can supply proper voltage for lighting requirements. Investigate this modern method of completely electrifying machinery.

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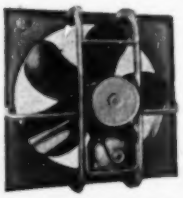

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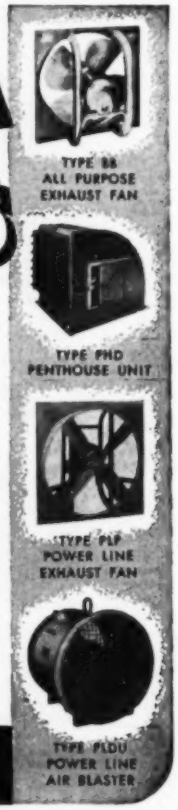

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Unretouched photograph of the screen of a Sarco Strainer, exactly as found, after brief service in a pipeline. Brimful of scale, rust and pipe dope.

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Bodies are of cast iron, semi-steel, cast steel, bronze or cast molybdenum steel. Screens are made of various metals with perforations as required.

Furnished with screwed, flanged, socket weld and sil-braze connections.

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SARCO saves steam

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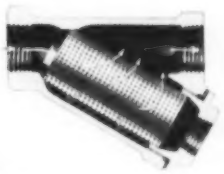
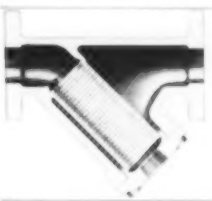


Sarco type SB and SBH strainers with screwed connections. Bodies of cast iron or bronze semi-steel or cast steel. Screens of brass, phosphor bronze, mild steel, stainless steel, or monel. Sizes ¼" to 6". For any commercial pressure.



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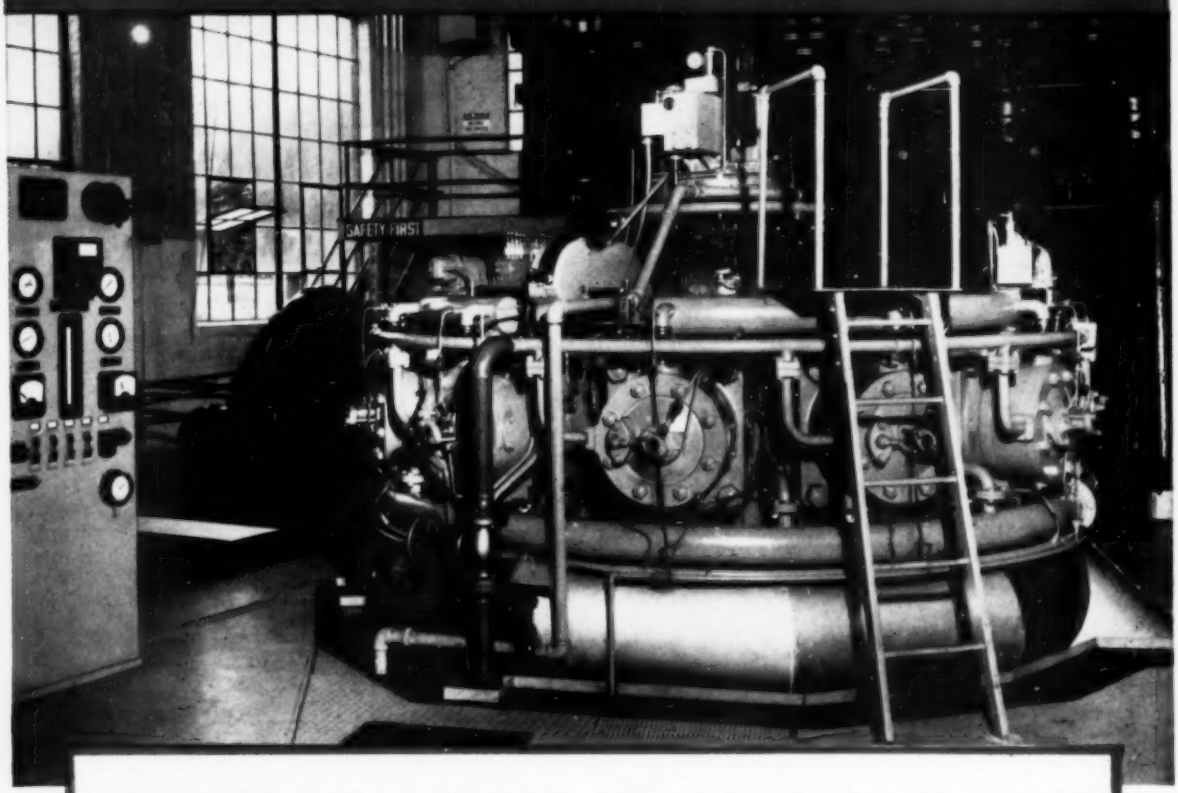

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